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Revision of the Genus Swertia (Gentianaceae) of the Americas and the Reduction of Frasera

Harold St. John

The genus *Frasera* was described in 1788 by Walter (Fl. Carol. 87-88, 1788) with a single species, *F. caroliniensis*. Numerous species from western North America were added by later authors and the genus was generally accepted, as it was by Asa Gray and by Bentham & Hooker, and by many others. Recently H. H. Card published a revision of the genus *Frasera* (Mo. Bot. Gard., Ann. 18:245-282, figs. 1-4, pl. 14-15, 1931), dissatisfaction with which induced the author to prepare these notes.

In a revision of a genus one expects to find a discussion of generic interrelationship and a demonstration by the use of evidence and deduction that the group is truly of generic status. In two places Card referred to the generic position of *Frasera*. He writes (p. 245), "In recent years it has received various treatments in the numerous local manuals and floras; certain authors have considered it a portion of the more polymorphic and widespread genus *Swertia*, others have regarded it as a distinct generic unit, whereas still others have segregated it into several smaller genera." Then, (on pp. 246-247) he continues, "Treatments of the genus have appeared in the various local manuals and floras; certain workers [footnote to Rydberg] have segregated the genus into several closely allied genera, namely *Frasera*, *Tessaranthium* and *Leucocraspedum;* on the other hand Gilg, in Engler and Prantl, 'Die Natürlichen Pflanzenfamilien,' and Jepson in his recent 'Manual' have merged the genus *Frasera* and its segregates with *Swertia*." No further evidence is presented by Card nor does he explain why he follows Gray in his acceptance of the genus and rejects the later treatments of Gilg and of Jepson.

The generic status of *Frasera* is not to be taken for granted. Gray himself noted that the possession of a slender style (the only difference from *Swertia*) was not always constant, as he wrote (Bot. Calif. 1:483, 1876), that in *F. thyrsiflora* Hook., "The style in the latter is short, as in *Swertia*." The flowers of *Frasera* are 4-merous, but those of *Swertia* are either 4- or 5-merous. *Frasera* was reduced to the synonymy of *Swertia* by H. Baillon in 1889 (Hist. Pl. 10: 142, 1889). Indicating the style character as not distinctive, O. Kuntze in 1891, discussed these generic relationships, placed *Frasera* in synonymy under *Swertia* (as *Sweertia*), and made the new combinations (Rev. Gen. Pl. 2:430-431, 1891). *Swertia* was accepted as an inclusive genus and *Frasera* was made a section under it by E. Knoblauch in 1894 (Bot. Centralbl. 60:392, 396-7,

1894). E. Gilg concurred with this treatment and placed the species described as *Frasera* in section Eusweertia of *Sweertia* [=Swertia], (Engler, A. & Prantl, K., Natürliche Pflanzenfamilien IV, 2:87-88, 1895). Kuntze in 1891 had changed the spelling of *Swertia* to *Sweertia*. Such modifications are not permitted by the present rules of nomenclature, so we must use the original spelling *Swertia*. Jepson in his latest treatment (Fl. Calif. 3:93-98, 1939) still retains the genus *Swertia* for all these species, and he makes one new combination. After study of the plants and review of the literature, the writer concurs that *Frasera* should be reduced to the synonymy of *Swertia*, as it has no morphological differences. As indicated by Gilg in Engler and Prantl (p. 78) and by C. K. Allen (Mo. Bot. Gard., Ann. 20:134-135, 1933) the closest related genus is *Halenia*. The two are distinguished as follows: *Swertia* lacks knobs or retrorse spurs, and it has the corolla lobes sinistrorsely convolute in the bud. *Halenia* has the corolla with retrorse knobs or spurs which lack any inner fringe; corona none; and the corolla lobes are dextrorsely convolute in the bud. *Swertia* appears to be a good and natural genus. The species are mostly recognizable by their peculiar habit, but they also have technical characters. The most fundamental are in the nature of the glandular spot or pit on each corolla lobe. It is a thickened glandular tissue and its margin is bounded by a ciliate fringe or a lacerate ciliate membrane. The shape and form of this gland or fovea, delimited by its fringed margin provides the best diagnostic characters, and in this present revision the term fovea is applied to the aperture of the gland. Some species have near the filament bases a corona of hairs or scales, others lack any corona, and this character, too, is important.

Card, in his history of the genus, (p. 246) states that "In 1839 two closely related species, *F. nitida* and *F. albicaulis*, were added to the genus." Yet, a few pages further on (p. 269), he gives the reference for *F. albicaulis* in Hooker's, Fl. Bor.-Am. as published in 1840. Actually neither of the two species was published in 1839 or 1840. Piper (U. S. Nat. Herb., Contr. 11: 451-452, 1906), who is cited by Card, gives both references correctly. *F. albicaulis* Griseb. was published in Hook., Fl. Bor.Am. 2:67, t. 154, 1838. To be sure the title page is dated 1840, but it is well known to botanists that this large work appeared in parts, published between 1829 and 1840. Volume 2, page 67 was published in July 1839. These exact dates were made known by B. Dayton Jackson (Herb. Boissier, Bull. 1:298, 1893) and they were reprinted in two American journals (Erythea 1:160, 1893, and Zoe 4:369-370, 1894). *F. nitida* Benth. was published in Pl. Hartweg. 322, 1849. Again the title page of this work bears the date 1839, but its actual publication dates extended from 1839 to 1857. The signatures bear the actual dates, and the one from page 317 to page 324 was dated August 1849. Hence 1849 is the date of the publication of *F. nitida*. The correction of these dates may seem scarcely worth while, but there is a point at issue. Card reduced *F. albicaulis* to a variety under *F. nitida*. If they truly bear this relationship, that of a variety to a species, then *F. nitida* which is younger, should be made the variety under *F. albicaulis*, which is the older species. Card states (p. 246) that the type of *F. albicaulis* was collected by "Douglas in the vicinity of Spokane, Washington, and Kettle Falls, British Columbia." Though not very important, this statement is errone-

ous. Grisebach described *Frasera albicaulis* (Hook., Fl. Bor.-Am. 2:67, t. 154, 1838) and gave its locality as "In the Mountain Vallies between Spokan and Kettle Falls, in moist soil. Mr. Douglas." So the locality was published as a single one, on the old trappers' route between Spokan [=Spokane, Washington] and Kettle Falls, which is also in Washington. Kettle Falls is a spectaular water fall of the Columbia River 8 miles west of Colville (the old Fort Colville), and just below the mouth of the Kettle River. It is about to be covered by the ponded Columbia River above the new Grand Coulee Dam. Kettle Falls is between Stevens and Ferry Counties, and is well shown on numerous modern maps, for instance on the map in Piper, C. V., Flora of the State of Washington (U. S. Nat. Herb. Contr. 11: 1906).

This *Frasera* groups is well represented in the Pacific Northwest, and the author has studied it, and published upon it. He has tested the recent revision. The key presented by Card is unsatisfactory in several places. At one place it is trichotomous and takes in the closely related group of *F. montana, F. nitida, F. coerulea* etc. separating them as follows:

D. Plants 3 dm. or more in height; flowers several in the axils.
DD. Plants from 1.5-2.5 dm. high; flowers one or two in the axils.

This separation on stature is unnatural and it is actually unworkable. The number of the flowers in the axils is not clearly diagnostic, as stated. At another subdivision the key character is:

F. Inflorescence about 3 cm. in diameter.
FF. Inflorescence about 2 cm. in diameter.

A rapid examination of the species shows that this character is neither practical nor actual.

The first key division separates the species that are not scapose but have the inflorescence foliaceous bracteate throughout. The three species included are the largest plants and those most conspicuously leafy. The corresponding division separates the species that are scapose to subscapose and the inflorescence not foliaceous bracteate throughout. This includes the twelve species and varieties that are smaller in stature and less leafy. Actually the writer finds no single species or variety that is truly scapose, and only in *F. albomarginata* and *F. tubulosa* do occasional individual plants approach this condition. Hence, this main division of his key is unworkable.

In the lower half of the key the second divisions are the trichotomous ones based on the presence of a rhizome instead of a tap-root, and leaves opposite instead of whorled. They are given the leading character as perennials, which all three possess, so this character is not diagnostic and should have no place in the key. Species nos. 4 to 8 are keyed as having rhizomes. Of these, no. 8 is *F. tubulosa* which Card himself in his description (p. 271) says is a "perennial from a tap-root." No. 4 is *F. neglecta* which Hall described as "arising from a single perpendicular tap root:" (Bot. Gaz. 31:388, 1901). The writer has examined all of these seven species and varieties. No one of them produces rhizomes, nor does any other species of *Frasera*, all of which grow from a woody or somewhat fleshy tap-root, which is vertical (or if so deflected, in part oblique or somewhat horizontal). On larger plants the crown may be divided and multicipital.

Emphasis was laid on such undependable characters as the stature of the plant and the diameter of the inflorescence, while in the floral structure excellent characters are observable, as in the size and form of the perianth and particularly of the scales of the corona, and in the nature of the fovea or glandular pit on the corolla lobes. Card's key is very unsatisfactory.

In the preparation of the revision Card examined the specimens in five herbaria. The research worker must always decide when he has seen an adequate amount of material, then decide how much of it should be cited. Card did not cite in his publication many specimens which he saw and annotated in the Gray Herbarium. For instance, he determined Watson 269 as *F. nitida* var. *albicaulis*, but did not cite this, the only Montana station, though he apparently maps it on p. 252. To be sure it was not typical material and it is here described as a new species, but Card neither cited nor discussed it. Examination of more material would have extended many other ranges, such as that of *F. caroliniensis* to Pennsylvania with four localities in the western part (in the Herb. University of Pennsylvania) and Arkansas, Hot Springs Co., Magnet Cove, *D. Demaree* 14855, 14994, (N. Y. Bot. Gard.), and *F. Parryi* and *F. speciosa* (=*S. radiata*) into Mexico (U. S. National Herbarium). None of the species are recorded for Canada, yet Macoun listed several localities for *F. caroliniensis* in Ontario (Cat. Can. Pl. 2:326, 1884) as did R. Cameron for Niagara Falls, Ontario (Cat. Pl. Queen Victoria Niagara Falls Park 27, 1895), and D. F. Day for Queenston Heights, Ontario (Cat. Niagara Fl. 39, 1888), and J. M. Dickson & A. Alexander for Hamilton, Ontario (Fl. Hamilton Dist. 20, 1896-97), and C. W. Nash for Ontario (Fl. Ont. 29, 1900). In the Gray Herbarium are four collections of *S. caroliniensis* from western New York, all annotated by Card, but he fails to cite or map them or any other records for New York. Other records of this species in New York are in the following publications: J. Torrey (Fl. State N. Y. 2:109-110, 1843); J. A. Paine (Cat. Pl. Oneida Co. 64, 1865); F. Beckwith, M. E. Macauley, & J. B. Fuller (Rochester Acad. Sci., Proc. 3:86, 1896, and 5:23, 1910); and C. A. Zenkert (Buffalo Soc. Nat. Sci., Bull. 16:224, fig. 225, 1934).

Card (pp. 251-252) limits the occurrence of the genus *Frasera* to the United States and so indicates it on his map. He writes "the distribution of the genus *Frasera* is limited to the region of North America lying between 25° and 50° North latitude, which is approximately coincident with the northern and southern boundaries of the United States." Such an approximation of the United States boundaries is certainly very inaccurate, as it would include the northern third of Mexico and would include much of the inhabited region of eastern Canada, reaching as far north as a point within 75 miles of James Bay. Card did not cite or map the Mexican material of *Frasera* in the Gray Herbarium, and he could have found a second Mexican species represented in the U. S. National Herbarium. These localities are cited below under *Swertia Parryi* and *S. radiata*. The locality in Tamaulipas, Mexico, is as far south as 23° 30′.

It is noticeable that in the list of exsiccatae (p. 276) that no specimens collected by Card himself are listed. A monographer cannot always see his

plants growing, but it is good practice to see as many as possible in order to know them as living plants and thus interpret better the dried herbarium specimens. Card's revision shows no evidence that he had studied and collected any of the species in the field, though one of the species even grows in Missouri and his study was done at the Missouri Botanical Garden.

F. Cusickii Gray (Am. Acad., Proc. 22:310, 1887) is made a variety under *F. nitida* Benth., though this combination had already been made by Nelson and Macbride (Bot. Gaz. 61:33, 1916). *F. coerulea* Mulford (Bot. Gaz. 19: 118-119, 1894) is maintained by Card (p. 271) as a good species. After comparing the two type specimens and the other collections in the Gray Herbarium and in other eastern and western herbaria, the writer is unable to detect any difference between the two. None is indicated in the descriptions. *F. coerulea* Mulford is hereby reduced to the synonymy of *Swertia Cusickii* (Gray) St. John.

Card in his revision publishes three new combinations. They are all reductions of previously described species to the status of varieties. None of these three combinations are maintained by the writer. Two of them, published by Grisebach, and Gray, are here retained as species. It is agreed that the third is a variety, but there is an earlier, available and valid, varietal name given by Jepson, which must be employed.

Swertia difformis L., Sp. Pl. 1:226, 1753 is listed by Card (p. 262) as a synonym of the later *Frasera caroliniensis* Walt., (Fl. Carol. 87, 1788). If it were truly a synonym and the specific name being available, *difformis* would have to be adopted in place of *caroliniensis*. The Linnaean type has been located and studied by Blake who reports (Rhodora 17:50-51, 1915) that it is really a *Sabatia*, and becomes the valid name, *Sabatia difformis* (L.) Druce (Bot. Exch. Club, Rept. 1913, 3(5):422, 1914) of the plant long known as *Sabbatia lanceolata* (Walt.) T. & G. Hence *Swertia difformis* L. does not belong in the synonymy of *S. caroliniensis* Walt.

Numerous species of *Swertia* have been described from Central America and South America. These have all been investigated, and it appears that all of them have been given the wrong generic placement. Most of them are now placed as synonyms of the various species of *Halenia*. Their disposition can be checked in the recent monograph of this genus by C. K. Allen (Mo. Bot. Gard., Ann. 20:119-222, 1933). Their correct placement is also indicated at the end of the present paper in the list of excluded species.

Studies for the present revision have occupied the writer at intervals for two years. He has studied all of the material of the genus in the Gray Herbarium, the New York Botanical Garden, the United States National Herbarium, the University of Notre Dame, the University of California at Berkeley, and the California Academy of Sciences. Type specimens or material of certain critical species has been examined from the collections of the University of Pennsylvania, the University of Michigan, the State College of Washington, and Pomona College.

A serious attempt has been made to examine the type specimens or isotypes of all the species and subdivisions of species of *Frasera* or *Swertia* native to the

United States, Canada, or Mexico, which include the total range of the genus on the western hemisphere.

It has not been possible to see any of the types preserved in Europe, since they are mostly in secret hiding places and are unavailable during the present war. These types in Europe include those of *F. albicaulis* Griseb., *F. carolinien-sis* Walt., *F. thyrsiflora* Hook., *nitida* Benth., *S. obtusa* Ledeb., *S. perennis* L., *F. speciosa* Griseb., and *F. verticillata* Raf. Of *F. nitida* two isotypes have been found in the United States. The writer would like very much to have seen the type of *S. perennis* L., as the species is here accepted as of circumpolar distribution. However, the species is common and homogeneous in Eurasia, and scores of authentic Eurasian specimens were available for comparison. The identity of the six remaining species is well understood. The type of *F. verti-cillata* Raf. was probably destroyed.

Of the type specimens in American herbaria, the following have not been examined: *S. albomarginata* (Wats.) Kuntze var. *Purpusii* Jepson, *Tesseran-thium radiatum* Kellogg, and *F. speciosa* Griseb. var. *angustifolia* Rydb. Kel-logg's type is reported to have been destroyed in the San Francisco fire. Authentic material of the two varieties listed has been studied. The type of *F. umpquaensis* Peck & Applegate is at Stanford University. It has not been seen, since the species was published after this manuscript was sent to press. However, an isotype was seen at the University of California, and paratypes in five other herbaria.

Key to the North American Species of Swertia

A. Foveae 2 on inner side of each corolla lobe,

B. Fovea oval to suborbicular, 0.6-0.9 mm. long; corona of sparse puberulence; anthers 1.5-1.8 mm. long; corolla solid blue or streaked or darker spotted, 10-16 mm. long, deeply 5-lobed, exceeding the calyx lobes; leaves typically opposite. ..... 1. *S. perennis*

B. Fovea elliptic, 3.5-7 mm. long; corona scales 7-9 mm. long, deeply hirsute ciliate or lacerate nearly to the base; corolla greenish white, purple dotted, 15-25 mm. long, deeply 4-lobed, shorter than the calyx; leaves verticillate,

C. Leaves puberulent. ..... 2. *S. radiata*

C. Leaves glabrous (but bracts minutely puberulent). ..... 2a. var. *macrophylla*

A. Fovea 1 on inner side of each corolla lobe,

D. Fovea not entire, instead lobed at tip or base; leaves white margined,

E. Fovea lobed at tip; crown sparse, of a few cilia,

F. Fovea broadly lunate, the tips ascending; corolla lobes 14-16 mm. long obovate-oval, acute; calyx lobes lanceolate to oblanceolate; bracts ovate-lanceolate, foliaceous; herbage glabrous; leaves opposite. 3. *S. Parryi*

F. Fovea linear-oblong, the apex broadened and notched; corolla lobes 8-10 mm. long, elliptic acute; calyx lobes linear-lanceolate; bracts linear-lanceolate, reduced; leaves whorled, but the bracts opposite,

G. Herbage glabrous. ..... 4. *S. albomarginata*

G. Herbage glandular puberulent. ..... 4a. var. *Purpusii*

E. Fovea lobed at base, sagittate to oblunate; leaves opposite,

H. Crown none; fovea oval, saccate, the fimbriate aperture suborbicular, the base sagittate; calyx lobes longer or even twice as long as the corolla; herbage puberulent; basal leaves 5-10 cm. long, oblanceolate. ..... 11. *S. puberulenta*

H. Crown of sparse puberulence; calyx lobes half the length of the corolla; herbage glabrous; basal leaves 5-20 cm. long; linear to linear-oblong. ..... 5. *S. utahensis*

D. Fovea entire,

I. Leaves whorled,

J. Leaves green, lacking a white margin; fovea oval to suborbicular, with a prominent cupulate rim densely hirsute ciliate; herbage glabrous,

K. Fovea 1/3 way from base of corolla lobe; crown sparse, of short glandular hairs (puberulent); corolla lobes greenish yellow, brownish-purple maculate, 13-18 mm. long; anthers linear-ellipsoid, 3.3-4 mm. long; lateral veins of leaves inconspicuous; capsules 15-22 mm. long. ..... 6. *S. caroliniensis*

K. Fovea subbasal; crown obsolete; corolla lobes bluish to white, 8-11 mm. long; anthers ovoid 0.8-1.5 mm. long; leaves with the pli-nerves and lateral nerves prominent; capsules 10-16 mm. long.

L. Crown obsolete or of a few hairs (hirsute); petals pale blue to bluish lavendar, 4-5.5 mm. wide, exceeding the narrowly deltoid calyx lobes; middle cauline leaves oval, acute. ..... 7. *S. fastigiata*

L. Crown of numerous long hairs (villous); petals greenish white or pale yellowish, 3.5-4 mm. wide, shorter than the linear calyx lobes; middle cauline leaves lanceolate. ..... 8. *S. umpquaensis*

J. Leaves with a prominent thickened, indurated white margin; fovea basal, the margin, prolonged into a tube half the length of the corolla lobe, the orifice oblique, lacerate fimbriate; stems glabrous; foliage minutely puberulent. ..... 9. *S. tubulosa*

I. Leaves opposite, the margins indurate, thickened, white,

M. Fovea broadly oval to orbicular,

N. Crown of sparse short hairs (puberulent); fovea 0.6-1.5 mm. long,

O. Fovea orbicular, 0.6-1 mm. in diameter; calyx 4-6 mm. long; cyme strict, conspicuously interrupted, the fascicles of flowers compact and subumbellate; herbage glabrous; basal leaves linear or nearly so, 4-11 mm. wide. ..... 10. *S. neglecta*

O. Fovea broadly oval, 1.3-1.5 mm. long; calyx 7-13 mm. long; cyme open, loose, not interrupted; herbage puberulent; basal leaves oblanceolate, 1-5 cm. wide. ..... 11. *S. puberulenta*

N. Crown of separate scales; fovea oval to obovate, 1-2 mm. long,

P. Crown scales obovate, sparsely lacerate above; corolla lobes creamy white; inflorescence in anthesis not or but slightly interrupted; herbage glabrous. ..... 12. *S. montana*

P. Crown scales oval, erose at apex or even emarginate; corolla lobes pale blue with darker spots or streaks; inflorescence in anthesis interrupted; herbage densely puberulent. ..... 13. *S. sierrae*

M. Fovea linear-oblong to elliptic,

Q. Herbage puberulent,

R. Herbage densely puberulent throughout,

S. Fovea naked and open at tip,

T. Corolla glabrous,

U. Crown scales 2-4 mm. long, obdeltoid, lacerate-ciliate or cleft to the base into numerous setae,

V. Corolla blue. ..... 14. *S. albicaulis*

V. Corolla white. ..... 14a. f. *alba*

U. Crown scales 1.5-2.5 mm. long, elliptic, entire or shallowly lacerate. ..... 15. *S. modocensis*

T. Corolla lobes puberulent without; crown scales 3.3 mm. long, narrowly elliptic, entire. ..... 16. *S. shastaensis*

S. Fovea narrowly elliptic to oblong, 0.5-1.3 mm. long, hirsute ciliate all around,

W. Fovea 1.2-1.3 mm. long, narrowly elliptic; corolla bluish streaked or lined; calyx lobes 5-7 mm. long; principal leaves

6-12 mm. long. .....17. *S. californica*
w. Fovea 0.5-0.6. mm. long, oblong; corolla apparently bluish, not streaked; calyx lobes 4-5 mm. long; principal leaves 3-4 mm. wide. .....18. *S. Watsonii*
R. Herbage sparsely puberulent below, the inflorescence glabrous; fovea 1.5-2.5 mm. long, linear,
X. Crown scales elliptic 1.5-2.5 mm. long; fovea elliptic, naked at tip; upper half of stem, upper leaves, and inflorescence glabrous. .....15a. *S. modocensis* var. *adglabra*
X. Crown scales of single long setae; fovea linear, hirsute all around the margin; only the inflorescence glabrous. .....19. *S. Bethelii*
Q. Herbage glabrous or only inconspicuously puberulent near the midrib on the upper leaf surface,
Y. Leaves puberulous near midrib on upper surface; fovea 1.5-2 mm. long, elliptic; crown scales 3.5-4 mm. long, obovate with a few shallow apical lacerations,
Z. Corolla blue. .....20. *S. columbiana*
Z. Corolla white. .....20a. Forma *albida*
Y. Herbage glabrous, (except in *S. Cusickii* which is puberulous along the midrib above),
a. Fovea 3 mm. long, lance-linear; crown scales 3-4 mm. long, elliptic, at tip deeply lacerate-fimbriate; corolla pale blue. .....21. *S. idahoensis*
a. Fovea 1-2.2 mm. long, elliptic to narrowly oblong,
b. Crown scales entire; corolla bluish,
c. Crown scales oval to suborbicular, 3-4 mm. long; fovea 1.8-2.2 mm. long; corolla lobes 9-11 mm. long. .....22. *S. Cusickii.*
c. Crown scales elliptic, 0.3 mm. long; fovea 1 mm. long; corolla lobes 5-5.8 mm. long.....23. *S. lassenica.*
b. Crown scales serrate, lacerate, or lobed, lanceolate to obovate; corolla whitish, yellowish, or pale bluish with purple dots or streaks,
d. Fovea 1.8-2.2 mm. long; crown scales 1.5-3 mm. long; corolla pale bluish with purple dots or streaks.....24. *S. nitida.*
d. Fovea 1-1.8 mm. long; crown scales 0.5-1.5 mm. long; corolla yellowish or whitish.....25. *S. Eastwoodae.*

1. SWERTIA PERENNIS L., Sp. Pl. 1:226, 1753.

S. obtusa Ledeb., Acad. St. Petersburg, Mém. **5**:526, 1814 [=1812, fide Roy. Soc. Cat. Sci. Papers].
S. perennis L. var. *obtusa* (Ledeb.) Ledeb. ex Griseb., Genera et Sp. Gentianearum 331, 1839.
S. scopulina Greene, Pittonia **4**:184, 1900.
S. occidentalis Greene, Pittonia **4**:184-185, 1900.
S. ovalifolia Greene, Pittonia **4**:185, 1900.
S. palustris A. Nels., Torrey Bot. Club, Bull. **28**:227, 1901.
S. congesta A. Nels., Torrey Bot. Club, Bull. **28**:228, 1901.
S. Covillei Greene, Leafl. Bot. Observ. Crit. **1**:77-78, 1904.
S. parallela Greene, Leafl. Bot. Observ. Crit. **1**:92, 1904.
S. Fritillaria Rydb., Torrey Bot. Club, Bull. **40**:465, 1913.

This is a circumboreal species occurring in the northern or mountainous parts of Europe, Asia, and North America. Quite early the fragmentation of this species was begun. In 1812 Ledebour set off the Asiatic plants as *S. obtusa*, then in 1839 reduced it to a varietal status. The writer cannot distinguish this from the Linnaean species. Grisebach accepted the var. *obtusa* and referred a collection from northwest North America to it (Gen. et Sp. Gent.

331-332, 1839). This variety was asserted to have the petals broader and more obtuse, the basal leaves more obtuse, and the cauline ones for the most part alternate. Gray accepted this interpretation and referred all the North American collections, occurring from the Rocky Mountains to Alaska to this variety (Synopt. Fl. N. Am. 2(1):125, 1878), and so did F. J. Smiley (Univ. Calif. Publ. Bot. 9:299, 1921). The writer finds no basis for segregation in the shape of the corolla lobes or the blades, and in all the leaves are normally opposite, only rarely on a few individuals are the leaves subopposite or even single at one or a few nodes. These few individuals occur with the normal ones and seem to be mere fluctuations.

By 1900 abundant collections of the boreal and montane *Swertiae* were available. In this year the process of splitting the species was begun and by 1913 eight segregates had been described from the homogeneous appearing material of *S. perennis* L. Prof. Edward L. Greene began the splitting, proposing three American segregate species, and arguing,

> I have long doubted that our North American representation of the genus SWERTIA is rationally to be accepted as constituting but a single species, and that the whole or any part of the material is properly referable to the Old World *S. perennis*. The only species often collected with us, and common in the herbaria under the name of *S. perennis*, is a Rocky Mountain plant, subalpine or even alpine as to its habitat, and very unlike the real *S. perennis*, both in habit and floral characters. The European plant has a somewhat loose and panicled inflorescence, with pentamerous flowers, while in ours the inflorescence is very strict and thyrsiform and the flowers tetramerous. The nectaries in the former are fringed with copious long and quite capillary appendages, while in ours they are bordered by only a few short dilated and broadly subulate ones. These are specific characters of the first class; and the discovery of them necessitates the recognition of a new species. . . .

Then Greene proceeds to describe as new *S. scopulina* and *S. occidentalis* with 4-merous flowers, and *S. ovalifolia* with 5-merous flowers. Each of these species was described only from a single collection. Greene did not state how many European collections of *S. perennis* he studied, but his own herbarium now contains but a single sheet from Switzerland. The examination of a good series of the European and the American plants reveals a very obvious similarity. On both continents the young or high alpine specimens are small, have shorter, broader, more obtuse leaves and a smaller, more condensed inflorescence while the older, larger, more vigorous plants and those from protected fertile habitats at lower elevations are taller, with more elongate, more acute leaves and a larger looser inflorescence. All intergradations occur, and the observed differences are clearly only fluctuations or responses to different ecological conditions. Slight but unimportant differences can be seen in the number and exact size of the hairs fringing the foveae. *S. perennis* of Europe is typically 5-merous, but individual plants with 4-merous or 6-merous flowers are occasionally found in Europe (Hegi, G., Ill. Fl. Mittel-Europa 5(3):1976, 1927). Likewise, the American specimens of this group are normally 5-merous, and the rare specimens reported as 4-merous are doubtless only aberrant individuals. Two sheets of Cusick 2100, isotypes of *S. occidentalis* Greene, have been studied in the Gray Herbarium and also the type in the Green Herbarium at the University of Notre Dame. They include in both herbaria several plants that are 4-merous,

and several that are 5-merous, but they differ in no other detail. In the Greene Herbarium at the University of Notre Dame there are two isotypic sheets of *S. scopulina* Greene, from Little Ouray Mt., Colorado, Sept. 3, 1896, E. L. Greene. They contain six plants with numerous flowers. All the flowers now visible are 5-merous. This was the first American segregate in this group, separated by Greene as having 4-merous flowers from the 5-merous European *S. perennis*. It is possible that this type material may have borne one or more 4-merous flowers which were noted by Greene, but it is obvious that tetramerous flowers are not diagnostic for this plant. As it has no other difference, it is here reduced to the synonymy of *S. perennis* L. Hundreds of specimens have been studied by the writer and they are almost invariably 5-merous, all but one of those in the Gray Herbarium and the New York Botanical Garden being 5-merous. Certainly the normal flower is 5-merous.

A. Nelson, Greene, and Rydberg, in succession, continued to describe new American species from this group, all but one described from single collections. *S. Covillei* Greene was described from one flowering and one fruiting collection. In general these descriptions were closely drawn, emphasizing characters of stature, exact size and shape of leaves, venation, exact size of floral parts. Later collectors have had difficulty, as evidenced in the herbaria, in matching their collection to these particular ones described. Nelson was the next to publish after Greene. In his discussion he stated "The old world *S. perennis* is wholly unknown to me but, with the characters which Dr. Greene assigns to it it is no longer possible to refer any of our forms to that. In fact to do so would be to reject the work already done." (Torrey Bot. Club, Bull. 28:228, 1901).

One more species of this group was published by Rydberg and two more by Greene, all described without any statement of relationship or distinctive characters. After a detailed and comparative study of all these segregates, using all or part of the collections of the Gray Herbarium, the New York Botanical Garden, the U. S. National Herbarium, the University of Notre Dame, and including the type specimens of all except *S. perennis* L. and *S. obtusa* Ledeb., the writer can see no significant differences, hence, he reduces them all to the synonymy of the circumboreal *S. perennis* L. The Linnaean type of *S. perennis* is in secret storage for safety during the present war, and the type of *S. obtusa* Ledeb. is likewise inaccessible to the writer. However, large series of the Eurasian collections have been examined.

S. perennis occurs in North America from Alaska to Montana, Washington, and southward to New Mexico, and California.

2. SWERTIA RADIATA (Kellogg) Kuntze, Rev. Gen. Pl. 2:430, 1891 (as *Sweertia radiatum*).

Frasera speciosa Griseb. in Hook., Fl. Bor.-Am. **2**:66, t. 153, 1838, not *S. speciosa* Wall., Cat. 4384, 1830.
Tesseranthium radiatum Kellogg, Calif. Acad. Sci., Proc. **2**:142-144, fig. 41, 1862.
F. speciosa Dougl. var. *scabra* M. E. Jones, Zoe **4**:277-278, 1893.
F. venosa Greene, Pittonia **4**:185-186, 1900.

F. ampla Greene, Pittonia **4**:186, 1900.
F. speciosa Dougl. var. *stenosepala* Rydb., Torrey Bot. Club, Bull. **31**:632, 1905.
F. speciosa Dougl. var. *angustifolia* Rydb., Torrey Bot. Club, Bull. **31**:632, 1905.
F. stenosepala (Rydb.) Rydb., Torrey Bot. Club, Bull. **33**:149, 1906.
F. angustifolia (Rydb.) Rydb., Torrey Bot. Club, Bull. **33**:149, 1906.
Tessaranthium speciosum (Dougl.) Rydb., Fl. Rocky Mts., 666, 1065, 1917.
T. angustifolium (Rydb.) Rydb., Fl. Rocky Mts., 666, 1065, 1917.
T. scabrum (M. E. Jones) Rydb., Fl. Rocky Mts., 666, 1065, 1917.
T. stenosepalum (Rydb.) Rydb., Fl. Rocky Mts., 666, 1065, 1917.

This large, handsome plant was well described originally by Grisebach in Hooker's Flora Boreali-Americana, but the name he chose was a later homonym, and, hence, is invalid. Kellogg provided the first available specific name in 1862.

This species is abundant in the mountains from South Dakota to Washington, southwards to New Mexico and California, and in Tamaulipas, Mexico. This most southern locality has not been recorded before.

MEXICO: mountains near Miquihuana, Tamaulipas, June 10, 1898, *E. W. Nelson* 4503 (Ca-Gr; US.).

2a. Var. **macrophylla** (Greene) comb. nov.

Frasera macrophylla Greene, Pittonia **4**:186, 1900.
Tessaranthium macrophyllum (Greene) Rydb., Fl. Rocky Mts., 666, 1065, 1917.

Of all the many proposed segregates, only this one with glabrous leaves seems to have any definite morphological basis. It has no other difference than the lack of pubescence. It occurs widely, nearly throughout the range of the species. Since the only character is the lack of pubescence on the leaves, while the floral bracts are minutely puberulent, it is proper to classify the plant as a variety. Specimens representing this variety are listed below.

WYOMING: Upper Hoback Basin, alt. 7500 ft., August 1-8, 1900, *C. C. Curtis* (NY). COLORADO: Pagosa Springs, July 25, 1899, *C. F. Baker* 524 (type US; isotype Ca-Gr; N. Y.); Keblar Pass, 10,000 ft., August 14, 1901, *C. F. Baker* 947 (Berk; NY.); Ironton Park, Ouray, alt. 2700 meters, *Underwood & Selby* 355 (NY.). NEW MEXICO: Bear Mt., 5 miles from Silver City, Grant Co., 6200 ft., July 12, 1928, *C. B. Wolf* 2621 (Ca-Gr.); Tularosa Creek, 3 miles south of Mescalero Agency, Otero Co., 6930 ft., July 19, 1928, *C. B. Wolf* 2785 (Ca-Gr.). ARIZONA: Rustler Park, 8500 ft., August 13, 1907, *J. C. Blumer* 1619 (Ca-Gr; NY.); Mt. Lemmon, July 4, 1926, *R. H. Peebles & C. J. Harrison* 2215 (Ca-Gr.); Huachuca Mts., 8000 ft., July 8, 1884, *C. G. Pringle* (Ca-Gr.); Santa Catalina Mts., Webbers Cabin, 7600 ft., June 27, 1917, *F. Shreve* 5291 (Berk; Ca-Gr.); Pine, 3 miles northwest of, 6000 ft., June 30, 1928, *C. B. Wolf* 2452 (Ca-Gr.). UTAH: Altus, vicinity of Salt Lake City, July 7, 1908, *Mrs. J. Clemens* (Ca-Gr.); Big Cottonwood Canyon, Salt Lake Co., July 22, 1905, *A. O. Garrett* (Ca-Gr.). OREGON: Bates, near Austin, moist borders of pine woods, Grant Co., June 5, 1925, *L. F. Henderson* 5324 (Ca-Gr.); Steins Mts. opposite Devine Ranch, 1890 meters, July 5, 1896, *J. B. Leiberg* 2426 (Berk; Ca-Gr.). CALIFORNIA: Trinity Summit, open places at Corral Prairie, Humboldt Co., alt. 5200 ft., July 20, 1932, *J. P. Tracy* 10731 (Berk.).

3. SWERTIA PARRYI (Torr.) Kuntze, Rev. Gen. Pl. 2:430, 1891. (as *Sweertia Parryi*).

Frasera Parryi Torr., Bot. Mex. Bound. Surv. 156, 1859.

It is abundant in the mountain ranges of Southern California, and also occurs in Lower California. The Mexican localities are listed below, apparently for the first time.

MEXICO, BAJA CALIFORNIA: Sierra de San Pedro Mártir, June 1923, *J. M. Gallegos* (US.); foothills of Sierra San Pedro Martir in vicinity of Rancho San Jose, 25 miles east of San Telmo, alt. 2600 ft., March 1, 1931, *A. Meling* 17 (US.); Nachoguero Valley, June 3, 1894, *E. A. Mearns* 3393 (US.); ditto June 5, 1894, *Mearns* 3486 (US.); northern Lower California, July 29, 1885, *C. R. Orcutt* 443 (US.).

4. SWERTIA ALBOMARGINATA (Wats.) Kuntze, Rev. Gen. Pl. 2:431, 1891 (as *Sweertia albomarginata*).

Frasera albomarginata Wats., Bot. King Exped. (U. S. Expl. 40th Parallel) 280, 1871.
Leucocraspedum albomarinatum (Wats.) Rydb., Fl. Rocky Mts. 665, 1065, 1917.

It occurs from Colorado and Arizona, westward to Southern California.

4a. Var. PURPUSII JEPSON, Man. Fl. Pl. Calif. 767, 1925.

Frasera inducta Tidestrom, Biol. Soc. Wash., Proc. **36**:183, 1923.
F. albomarginata Wats. var. *inducta* (Tidestr.) Card, Mo. Bot. Gard., Ann. **18**:275, 1931.

This plant is very similar to *S. albomarginata* except for its being finely glandular puberulent. It occurs within the range of the species. Its difference justifies its being kept as a variety but certainly not as a species.

It occurs in Nevada and California.

5. **Swertia utahensis** (M. E. Jones) comb. nov.

Frasera paniculata Torr., Rept. Bot. Pacif. R. R. Repts. **4**:126, 1856, not *S. paniculata* Wallich, Cat. 4374, 1830 (nomen), validated in Pl. As. Rar. **3**:3, t. 205, 1832.
F. Utahensis M. E. Jones, Zoe **2**:13-14, 1891, April.
S. Bigelowii Kuntze, Rev. Gen. Pl. **2**:431, 1891, November 5. (as *Sweertia Bigelowii*).
Leucocraspedum utahense (M. E. Jones) Rydb., Fl. Rocky Mts., 665, 1065, 1917.

The specific name *paniculata* is unavailable in *Swertia* because of its earlier use in 1832 by Wallich for a different, Asiatic species. Realizing this, Kuntze in November 1891 renamed the species *S. Bigelowii*. Card lists another synonym, *Frasera utahensis* M. E. Jones, which as it was published in April 1891, a few months earlier, may provide the first available specific name. The present writer had some doubts about its being a synonym of this species as the description of the fovea sounds rather different. None of the large eastern American herbaria consulted contained the type material: M. E. Jones, June 19, 1890, on the Buckskin Mountains (Kaiba Plateau), on the southern edge of Utah. Dr. P. A. Munz has kindly loaned three pertinent sheets from the Jones herbarium at Pomona College. They are all of this species, *F. utahensis* Jones, are collected on June 18, 1890. Two are from Jacob's Pools, Ariz., and one from House Rock, Ariz., this latter being marked "Type material." It will be seen that this wording is for a different state as well as locality and day. However, it is on the Kaiba [or Kaibab] Plateau, and the Arizona-Utah state boundary crosses in this vicinity. These Jones collections are not numbered, and there seems to be a confusion between the written and the published data.

It is not the first time that such confusion has been found in Jones' collections. Hence, it is reasonable to accept the sheet so marked as the type, as it conforms well to the diagnostic characters given in the original description. The type locality would then be: Arizona, House Rock, June 18, 1890, Marcus E. Jones (Herb. Pomona). There is an isotype in the herbarium of the University of California, at Berkeley. In all details *F. utahensis* Jones is found to agree with those of *F. paniculata* Torrey. Hence *utahensis* must be adopted as the first available name. Type material of *F. paniculata* Torrey is preserved in both the New York Botanical Garden and the Gray Herbarium. It is good, characteristic material, but well advanced in fruiting. Torrey's description of the gland was brief, "foveis, oblongo-linearibus binis;" while Jones' description of his *F. utahensis* was much more detailed. The writer, after examining extensive collections would recast the description of this important and diagnostic organ, as follows: Fovea with an apical semiorbicular cordate based portion, sparsely short hisutulous around the margin, confluent with this apical portion and decurrent from it are two narrowly elliptic sacs, each with the base and sides with a projecting membranous margin deeply lacerate hirsute-ciliate, the basal portion for about 0.5 mm. is a closed covered sac or tube, the whole orifice of the fovea about 2.5 mm. wide, 3-3.5 mm. long. The description and figure (p. 276; pl. 14, fig. 2) of the fovea given by Card are inaccurate.

S. utahensis (F. paniculata) occurs in southern Utah, southern Nevada, northern New Mexico, and northern Arizona. Card (p. 276) cites specimens in the Gray Herbarium which he had examined and annotated from Utah, and a Searls specimen from Pahranagath Mts., Arizona. This latter specimen actually bears the data Pahranagat Mts., S. E. Nevada. This seems still to be an accepted spelling (see Rand McNally atlas) and the locality is certainly in Nevada, not Arizona. Card (p. 252) does not map this species *(F. puberulenta)* as occurring in either Utah or Nevada, though he saw and annotated specimens from both states.

6. SWERTIA CAROLINIENSIS (Walt.) Kuntze, Rev. Gen. Pl. 2:430-431, 1891 (as *Sweertia carolinensis*).

Frasera caroliniensis Walter, Fl. Carol. 87-88, 1788.
F. Walteri Michx., Fl. Bor.-Am. **1**:97, 1803.
F. officinalis B. S. Barton, Fl. Virginica, 49-50, 1812.
S. Frasera Sm. in Rees' Cyclop. **34**:1819 [=1816, fide B. D. Jackson in 1895].
F. verticillata Raf., Med. Fl. **1**:199-201, 1 pl., 1828.

This, the only eastern species, was the type species of the genus *Frasera*, monotypic when published by Thomas Walter. A recent paper by R. W. McCoy gives details of the anatomy and development of the floral organs (Am. Journ. Bot. 27:600-609, figs. 1-22, 1940). He shows the development of the gland or fovea on the upper surface of the corolla lobes and states that it has its own vascular strands.

The species occurs from Ontario, New York, Pennsylvania to Georgia and from Wisconsin to Arkansas.

7. *Swertia fastigiata* Pursh, Fl. Am. Sept. 1: 101, 1814.

Frasera thyrsiflora Hook., Journ. Bot. Kew Miscell. **3**:288, 1851.
F. fastigiata (Pursh) Heller, Torrey Bot. Club, Bull. **24**:312, 1897.
"*Sweertia fastigiata* Pursch" acc. to Kuntze, Rev. Gen. Pl. **2**:430, 1891.

A large, handsome species, abundant in the open woods of eastern Washington and northern Idaho.

In Card's revision (p. 265) the description of the floral bracts, instead of "2-10 cm. long," should read: 2-10 mm. long. Also the Spalding specimen from Clearwater, Oregon, should not be credited to Washington, but to Idaho, as Spalding's mission and home and most of his plant collections were made at the present Lapwai, Idaho.

8. **Swertia umpquaensis** (Peck & Applegate) comb. nov.

Frasera umpquaensis Peck & Applegate, Madroño **6**:12, 1941.

Perennial with a dark, thickened tap-root 15 mm. in diameter; shoot one, terminal, 6-9 dm. tall; herbage glabrous; leaves 3-4 in a whorl, but the uppermost opposite, membranous, all bearing blades; first basal leaves 3.5 cm. long, oblanceolate; principal basal leaves 15-27 cm. long, including the winged petiole, the blade 4-7 cm. wide, oblanceolate, acute, entire, above glandular atomiferous; cauline leaves in whorls, usually of 3 at 3-4 nodes, gradually reduced to the base of the inflorescence, the upper surface glandular atomiferous; median and upper cauline leaves 8-18 cm. long, 3-6 cm. wide, sessile, lanceolate; inflorescence a glabrous, narrow thyrse, in anthesis 1-3.5 dm. long, 2-4 cm. in diameter, interrupted, the lower internodes as much as twice or thrice as long as the flower clusters; flower clusters sparse, ascending; floral bracts narrowly oblong, acute, exceeded by the flowers; pedicels 6-12 mm. long; flowers 4-merous; calyx cleft almost to the base; calyx lobes 9-12 mm. long, 1.2-1.8 mm. wide, green, linear, acute, broadest at or above the middle, each with a tuft of short setae at base within; corolla "greenish white or pale yellowish"; corolla tube 0.5 mm. long, saucer-shaped; corolla lobes 9-11 mm. long, 3.5 mm. broad, oblong-elliptic, acute, each bearing a single subbasal fovea, suborbicular, 1.4-1.6 mm. in diameter, the orifice with a raised membranous rim densely villous ciliate, the closed covered base adnate to the base of the corolla lobe and sparsely villous; corona of numerous long hairs (villous); filaments 3-4.5 mm. long, subulate; anthers 1.3-1.6 mm. long, broadly oval, sagittate at base; style 0.5-0.8 mm. long; capsules compressed.

OREGON: Anderson Camp, Rogue-Umpqua Divide, upper waters of Rogue River, northeastern Jackson Co., July 11, 1929, *E. I. Applegate* 5930 (type in SU; isotype in Berk.); Abbott Butte, alpine slopes, 6000 ft., Rogue River National Forest, July 2, 1936, Jackson Co., *J. W. Thompson* 13067 (NY; Ca-Gr; SF; US; WSC.).

This species was written up as new by the author, based upon the same two collection numbers used by Professors Peck and Applegate who distinguished it as new in the herbaria of Willamette and of Stanford Universities. Their studies and the author's were concurrent but quite independent. They published the new species in the genus *Frasera* while this paper was in press. Duplicate

specimens were seen by the author in six different, large American herbaria, and annotated with a new specific name. As here concluded, *Frasera* is not a distinct genus, so the new species is transferred to *Swertia*. For comparison with the other species of *Swertia*, a full description is included. Judging from the dried specimens, the corolla seemed to be white or partly tinged with pale bluish. The labels do not include any color data. Since Applegate collected one of the two numbers, his published statement of the color is accepted: that the corolla is greenish white or pale yellowish. They also add that the capsules are compressed and they considered the plants to be biennial, while to the writer they seemed perennial. In other details our two descriptions were in agreement.

The closest related species is *S. fastigiata* Pursh of northeastern Oregon, eastern Washington and northern Idaho, which differs in having the crown none or of a few hairs (hirsute); the petals 4-5.5 mm. wide, pale blue to bluish lavender; calyx lobes 6-9 mm. long, narrowly deltoid, broadest at base, exceeded by the corolla lobes; inflorescence many flowered, a thyrse with densely many flowered, compact clusters.

9. SWERTIA TUBULOSA (Cov.) Jepson, Man. Fl. Pl. Calif. 767, 1925.
Frasera tubulosa Cov., Biol. Soc. Wash., Proc. **7**:71, 1892.

A very distinct species, with remarkable floral structure. The gland is basal, with the margin prolonged into a membranous narrow cylindric tube half the length of the corolla lobe and the orifice oblique, lacerate fimbriate. No other of our species have such a long protrusion of the fovea.

It occurs only in California.

10. SWERTIA NEGLECTA (Hall) Jepson, Man. Fl. Pl. Calif. 766, 1925.
Frasera neglecta Hall, Bot. Gaz. **31**:388-389, pl. X, 1901.

This is a stiff, glabrous plant, with interrupted inflorescence, and an orbicular fovea. It is easily recognizable.

It occurs in the mountains of southern California.

11. SWERTIA PUBERULENTA (Davidson) Jepson, Fl. Calif. 3:95, 1939.
Frasera puberulenta Davidson, So. Calif. Acad. Sci., Bull. **11**:77, pl. 1, 1912.

Descriptions are included by Davidson, Card, and by Jepson, so one is unnecessary here. This species is included in two places in the key, because it has been described and illustrated by others as having the fovea sagittate at base. An isotype and two other collections of this rare species have been examined. The outline of the fovea, that is of its hirsute-ciliate aperture is not sagittate, but is broadly oval, 1.5 mm. long. Surrounding this is a larger glandular area, 2.5-3 mm. long, 1-1.5 mm. wide, covered with a membrane oblance-elliptic in shape, sagittate at base, and clearly distinguishable from the area fused to the base of the corolla lobe. The type and the isotype have the data on the labels worded differently.

CALIFORNIA: South Lake, Bishop Creek, Inyo Co., July 1911, *A. Davidson* 2705 (type in LA.), not seen by the writer, but illustrated by a photograph by Card in his

revision, pl. 15); North Lake, Bishop Creek, July 1911, *A. Davidson* 2705 isotype in Berk.); Big Pine Creek, Inyo Co., Sierra Nevada, at 10,000 ft., August 5, 1921, *F. W. Peirson* 2640 (Cla.); volcanic Mts. between Deadman Creek and June Lake, Mono Co., at 8,000 ft., June 26, 1927, *F. W. Peirson* 7560 (Cla.).

This is a very rare species which is not represented in any of the large herbaria of the eastern United States.

12. **Swertia montana** (Mulford) comb. nov.

Frasera montana Mulford, Bot. Gaz. **19**:119, 1894.
Leucocraspedum montanum (Mulford) Rydb., Fl. Rocky Mts. 665, 1065, 1917.

This is clearly distinct, and can be recognized as follows: The corolla is 6-8 mm. long, creamy white; the fovea is 1 mm. long, obovate or broadly oval, covered by the numerous white, long hirsute ciliations; the scales of the corona are 1 mm. long, obovate, sparsely lacerate above. Besides the type specimen collected by Mulford at Pioneer, Idaho, July 23, 1899 (NY), the following collections can be cited in addition to the two listed by Card.

IDAHO: Middle Fork Wieser River, Washington Co., alt 4,500 ft., July 15, 1899, *M. E. Jones* 6454 (Ca-Gr; US.); Lake Payette, Valley Co., open timber at 5,000 ft., July 8, 1937, *J. W. Thompson* 13726 (Ca-Gr; NY; U.Pa.); Clear Creek, Boise, sunny hills, alt. 5,000 ft., July 4, 1911, *J. A. Clark* 88 (Ca-Gr.); Jordan Creek, Custer Co., dryish slopes, alt. 6,500 ft., July 26, 1916, *J. F. Macbride* & *E. B. Payson* 3444 (Ca-Gr; NY; US.).

13. **Swertia sierrae** sp. nov.

Perennial from a yellowish, woody tap-root 3-7 mm. in diameter, crown of the root bearing several fertile and sterile shoots; herbage densely puberulent; stems 22-28 cm. tall; leaves opposite; lowest pair of leaves with short, foliaceous blades; lower leaves the best developed, numerous, crowded, erect, forming a bunch, the leaves 5-10 cm. long, 5-12 mm. wide, spatulate, obtuse or emarginate, thick, firm chartaceous, white margined, the midrib prominent, the 2 lateral nerves scarcely evident; upper leaves 2.5-5 cm. long, linear or slightly spatulate, remote; inflorescence a narrow, subcylindric thyrse, becoming interrupted, in anthesis 3-9 cm. long; floral bracts linear, usually not exceeding the peduncles the upper ones reduced; pedicels 2-4 mm. long; flowers 4-merous; calyx lobes 3-5.5 mm. long, ovate-lanceolate green and foliaceous and puberulent except on the white membranous margins; corolla pale blue with darker spots or streaks; corolla tube 0.5 mm. long, saucer-shaped; corolla lobes 5.5-7.5 mm. long, lanceolate, each bearing a single fovea 1-2 mm. long, broadly oval, covered by the hairs of the hirsute ciliate margin, the closed, covered base fused to the base of the corolla lobe for 1-5 mm.; corona of separate scales oval, towards the apex erose or even emarginate, 0.8-1.8 mm. long; filaments 4.5-5 mm. long; anthers 1.6-2 mm. long, narrowly oblong; style 2-3 mm. long; fruit oval, flattened, beaked, brownish, 7-10 mm. long, 3-5 mm. wide; seeds oval, flattened, brown, 4.5-5.5 mm. long.

Perennis puberulenta, radice lignosa lutea 3-7 mm. diametro, caulibus plurimis 22-28 cm. altis, foliis oppositis infimis brevioribus laminiferis, foliis inferioribus maximis multis erectis 5-10 cm. longis 5-12 mm. latis spatulatis

obtusis emarginatisve firme chartaceis albi-marginatis costa evidente nerviis lateralibus inconspicuis, foliis superioribus 2.5-5 cm. longis remotis linearibus vel lineari-spatulatis; thyrsis angustis deinde interruptis 3-9 cm. longis, bracteis linearibus quam pedunculum brevioribus superis reductis, pedicellis 2-4 mm. longis, floribus 4-partitis, lobis calycorum 3-5.5 mm. longis ovato-lanceolatis viridibus foliaceis puberulentis marginibus membranaceis glabris, corollis pallide coeruleis maculatisque, tuba corollae 0.5 mm. longa patelliforme, lobis 5.5-7.5 mm. longis lanceolatis, foveis 1-2 mm. longis late ovalibus marginibus ciliatis, coronis 4-partitis squamis ovalibus ad apicem erosis vel emarginatis 0.8-1.8 mm. longis, filamentis 4.5-5 mm. longis, antheris 1.6-2 mm. longis anguste oblongis, stylis 2-3 mm. longis, fructibus ovalibus pallide brunneis 7-10 mm. longis, seminibus ovalibus brunneis 4.5-5.5 mm. longis.

CALIFORNIA: Madeline, about two miles north of, gentle northeast facting slope, in rocky volcanic soil, among Artemisia and scattered Juniperus occidentalis, alt. 4,500 ft., Lassen Co., June 8, 1936, *E. B. Babcock & G. L. Stebbins* 1790 (type in Ca-Gr.); Willow Creek, Devils Garden, northern California July 1895, *Mrs. R. M. Austin* 418 (US.); Dry Lake, Modoc Co., May 31, 1897, *E. I. Applegate* 877 (US.). OREGON: Thomas Creek Ranger Station, Lake Co., 1,570 meters, June 29-30, 1911, *W. W. Eggleston* 5098 (Ca-Gr; NY; US.); Stein's Mountain, June 1, 1885, *T. Howell* (US.); near Warm Range, alt. 1,500 meters, Lake Co., July 26, 1896, *F. V. Coville & J. B. Leiberg* 53 (US.).

This represents, in part, the plant treated as *S.* (or *F.*) *albicaulis* in the floras of California. That species seems restricted to the Pacific Northwest and to be absent from California. The close relative of the new species is *S. albicaulis* (Griseb.) Kuntze which differs in having the fovea 2.5-5 mm. long, linear-oblanceolate; corolla lobes 5-10.7 mm. long; and the scales of the corona 2-4 mm. long, obdeltoid, sharply lacerate hirsute-ciliate.

The specific name alludes to the occurrence of the plant in the general region of the Sierras of California.

14. SWERTIA ALBICAULIS (Griseb.) Kuntze, Rev. Gen. 2:430, 1891.

Fraseria albicaulis Griseb. in Hook., Fl. Bor.-Am. **2**:67, t. 154, 1838.
F. nitida Benth. var. *albicaulis* (Dougl.) [=Griseb.] Card., Mo. Bot. Gard., Ann. **18**:269, 1931.

The name *S. albicaulis* is attributed to Douglas by Jepson (Man. Fl. Pl. Calif. 766, 1925, and Fl. Calif. 3(1):94, 1939), perhaps following the listing of this name in the Index Kewensis. However, the name by Douglas was only an herbarium name, published solely in synonymy.

This species with its puberulent herbage is distinguished by its fovea 2-5 mm. long, linear-oblanceolate, densely hirsute-ciliate to or nearly to the tip; scales of the corona 2-4 mm. long, obdeltoid sharply lacerate hirsute ciliate or cleft to the base into numerous setae; corolla lobes 5-10.7 mm. long, blue, not blotched. It seems a clearly defined species, and not one merging with *S. nitida*. It occurs in eastern Washington, eastern Oregon, and northern Idaho.

14a. Forma **alba** (St. John) comb. nov.
Frasera albicaulis Griseb. forma *alba* St. John, Biol. Soc. Wash., Proc. **41**:196, 1928.

This is a form with albino flowers, which occurs sporadically within the range of the species.

15. **Swertia modocensis** sp. nov.

Perennial from a yellowish or brown tap-root 3-6 mm. in diameter; crown of root bearing 1-2 fertile shoots and usually 1 sterile shoot; herbage finely puberulous; stems 16-35 cm. tall; leaves opposite, all blade-bearing, the first pair reduced; principal basal and lower cauline leaves numerous 4-17 cm. long, 3.5-9 mm. wide, spatulate, firm chartaceous, 3-nerved, with a prominent white margin; upper leaves 35-65 mm. long, 3-7 mm. wide, linear or linear spatulate; inflorescence puberulous, in anthesis 4-17 cm. long, a moderately dense ovoid or lanceoloid thyrse, becoming interrupted in the lower part; floral bracts lanceolate, subfoliaceous, not exceeding the pedicels, except the lowest pair which are leaf-like and linear and exceeding the pedicels; pedicels 3-13 mm. long; flowers 4-merous; calyx lobes 4-6 mm. long, nearly distinct lanceolate, thick firm foliaceous and green, puberulent, but the narrow smooth white margin membraneous; corolla pale lavender with dark greenish purple streaks; corolla tube 0.5 mm. long, saucer-shaped; corolla lobes 7-8 mm. long, oval, obtuse or subacute, each bearing a fovea 1-3 mm. long, elliptic or oblong-elliptic, the margin hirsute ciliate except at the broad open apex, the closed base fused to the base of the corolla lobe for 1.5 mm.; corona of 4 separate scales 1.5-2.5 mm. long, elliptic, entire or shallowly lacerate; filaments 5-6 mm. long, subulate; anthers 2-2.8 mm. long narrowly elliptic to elliptic-oblong; pistil glabrous; style included; fruit unknown.

Perennis puberulenta, radice 3-6 mm. diametro, caulibus 16-35 cm. altis, foliis oppositis omnibus laminiferis infimis inferioribusque maximas multis 4-17 cm. longis 3.5-9 mm. latis spatulatis firme chartaceis trinervatis albi-marginatis, foliis superis 35-65 mm. longis 3-7 mm. latis linearibus vel linearis-spatulatis, thyrsis puberulentis 4-17 cm. longis deinde interruptis, bracteis lanceolatis infimis linearibus, pedicellis 3-13 mm. longis, floribus 4-partitis, lobis calycorum 4-6 mm. longis subdistinctis puberulentis lanceolatis foliaceis viridibus marginibus albis membranaceis, corollis pallide griseo-caeruleis et viridi-purpureo-lineatis, tuba corollae 0.5 mm. longa patelliforme, lobis corollae 7-8 mm. longis ovalibus obtusis vel subacutis, foveis 1-3 mm. longis ellipticis vel oblongo-ellipticis marginibus hirsuto-ciliatis apice nudo, squamis 1.5-2.5 mm. longis ellipticis integris vel sublaceratis, filamentis 5-6 mm. longis subulatis, antheris 2-2.8 mm. longis ellipticis, stylo incluso, fructibus ignotis.

CALIFORNIA: Madeline, about two miles north of, alt. 4500 ft., gentle northeast facing slope, in rocky volcanic soil, among Artemisia and scattered Juniperus occidentalis, Lassen Co., June 8, 1936, *E. B. Babcock & G. L. Stebbins Jr.* 1790 (type in Berk.); 12 mile Creek, east side of Mt. Bidwell, open stony flats, northeastern Modoc Co., 1907, *Mrs. M. H. Manning* (Berk.); Fall River Mills, Shasta Co., May 17, 1923, *Ellsworth Bethel*, in part, that is the two puberulent plants on the left-hand side of the sheet, (SF.). OREGON: Deep Creek, July 1898, *Mrs. R. M. Austin & Bruce* 2153 (Berk.); between Merrill and Cottonwood, Expedition to Fossil Lake, Southern Oregon, June 1901, *H. W. Furlong, W. B. Greeley, M. Wilson & A. Alexander*, in part, that is the single rootless stem, (Berk.).

This new species, *S. modocensis* St. John occurs in Modoc County and the

adjacent regions of northeastern California and southern Oregon. Its closest relative seems to be the new *S. shastaensis* St. John which differs by having the corolla lobes puberulent, and the crown scales 3.3 mm. long, narrowly elliptic, and entire.

15a. Var. **adglabra** var. nov.

Differing from *Swertia modocensis* by having the upper half of the stem, the upper leaves, and the inflorescence glabrous.

Dimidia supera plantae glabra.

OREGON: between Merrill and Cottonwood, Expedition to Fossil Lake, Southern Oregon, Klamath Co., June 1901, *H. W. Furlong, W. B. Greeley, M. Wilson, & A. Alexander*, in part, that is the plant with roots (type in Berk.).

Since this plant differs only by being hairless in its upper half, and as its important floral characters coincide with those of *S. modocensis*, it is logical to describe it as a smooth variety of that species. If the collectors' data are accurate, the two plants grow side by side.

The name is coined from the Latin, *ad*, upwards; and *glaber*, without hair.

16. **Swertia shastaensis** sp. nov.

Perennial from a yellowish or brownish tap-root 4-6 mm. in diameter; crown of root bearing 2-3 fertile and several leafy shoots; herbage puberulent throughout; stems 15-29 cm. tall; leaves opposite, all blade-bearing, the lowest but little reduced; principal basal and lower cauline leaves numerous, erect, 4-10 cm. long, 5-8.5 mm. wide, linear-spatulate, thick, firm chartaceous, obscurely 3-nerved, with a prominent white margin; upper leaves 3-4.5 cm. long, 4-5 mm. wide, linear obtuse; inflorescence in anthesis 2-10 cm. long, a moderately dense thyrse, subcylindric, puberulent; floral bracts 2-5 mm. long, lance-linear; pedicels 3-12 mm. long; flowers 4-merous; calyx lobes 4-6 mm. long, nearly distinct, narrowly lanceolate, puberulent all over the back, foliaceous with a narrow white, membranous margin; corolla apparently pale or whitish; corolla tube 0.2 mm. long, saucer-shaped; corolla lobes 6-7 mm. long, elliptic, acute, puberulent on the back, but the margins glabrous, each bearing a fovea 3.5 mm. long, narrowly oblong, the margin villous at base, the hairs diminishing upwards, the upper third naked, the closed base fused to the base of the corolla lobe for 1 mm.; corona of 4 separate scales 3.3 mm. long, narrowly elliptic, obtuse, entire; filaments 5-6 mm. long, subulate, the base dilated; anthers 2 mm. long, narrowly oblong; ovary glabrous; style not equaling the corolla; capsule 9-10 mm. long, oval, flattened, stramineous.

Perennis puberulenta, radice lignosa 4-6 mm. diametro, caulibus 15-29 cm. altis, foliis oppositis laminiferis infimis inferioribusque maximis multis erectis 4-10 cm. longis 5-8.5 mm. latis lineari-spatulatis crasse chartaceis trinervatis albi-marginatis, foliis superis 3-4.5 cm. longis, 4.5 mm. latis linearibus obtusis, thyrsis 2-10 cm. longis subcylindraceis puberulentis, bracteis 2-5 mm. longis lanceo-linearibus, pedicellis 3-12 mm. longis, floribus 4-partitis, lobis calycorum 4-6 mm. longis subdistinctis anguste lanceolatis puberulentis foliaceis marginibus albi-membranaceis, tuba corollae 0.2 mm. longa patelliforme, lobis corollae

6-7 mm. longis ellipticis acutis puberulentis, foveis 3.5 mm. longis anguste oblongis marginibus ciliatis apice nudo, squamis 3.3 mm. longis anguste ellipticis integris obtusis, filamentis 5-6 mm. longis subulatis, antheris 2 mm. longis anguste oblongis, ovariis glabris, capsulis 9-10 mm. longis ovalibus compressis.

CALIFORNIA: Mount Shasta, near Sheep Rock, 5000 ft. alt., June 1903, *H. M. Hall & E. B. Babcock* 4113 (type in Berk.).

Known to the writer by only a single collection, but it is ample and shows both flowers and fruit. It is most closely related to *S. modocensis* St. John of northeastern California and adjacent Oregon, which is also here described as a new species. The latter species differs by having the corolla glabrous, the fovea 1-3 mm. long, and the crown scales 1.5-2.5 mm. long, entire or shallowly lacerate.

17. **Swertia californica** sp. nov.

Perennial from a yellowish tap-root 8 mm. in diameter; crown bearing several leafy as well as fertile shoots; herbage puberulent; stems 30-37 cm. tall; leaves all blade-bearing; the basal and lower cauline ones the principal leaves, numerous and forming an erect bunch, 6-14 cm. long, 6-12 mm. wide, spatulate, firm chartaceous, white margined, 3-nerved; upper leaves 3-11 cm. long, 3-5 mm. wide, linear, acute; inflorescence in anthesis 13-20 cm. long, a loose, cylindric thyrse; floral bracts linear or lance-linear the upper shorter than the peduncles: pedicels 3-22 mm. long; flowers 4-merous; calyx-lobes 5-7 mm. long, nearly distinct, narrowly linear-lanceolate, foliaceous and puberulent except for the whitish membranous margins; corolla bluish streaked or lined on an apparently whitish ground color; corolla tube 0.5 mm. long, saucer-shaped; corolla lobes 5.5-7 mm. long, lance-ovate, acute, each bearing a fovea 1.2-1.3 mm. long, narrowly elliptic, the margin long hirsute ciliate, the closed base fused to the base of the corolla lobe for 1 mm.; corona of 4 separate scales 2-3 mm. long, oval deeply lacerate ciliate near the apex; filaments 5-6 mm. long; anthers 1.2-1.5 mm. long, narrowly oblong; style 3 mm. long; fruit beaked, the oval body 8-10 mm. long.

Perennis puberulenta, radice lignosa lutea 8 mm. diametro, caulibus plurimis 30-70 cm. altis, foliis omnibus laminiferis, foliis infimis inferioribusque maximis numerosis erectis confertis 6-14 cm. longis 6-12 mm. latis spatulatis firme chartaceis trinervatis albi-marginatis, foliis superis 3-11 cm. longis 3-5 mm. latis linearibus acutis, thyrsis 13-20 cm. longis laxe cylindraceis, bracteis linearibus vel lanceo-linearibus superis quam pedunculum brevioribus, pedicellis 3-22 mm. longis, floribus 4-partitis, lobis calycorum 5-7 mm. longis subdistinctis anguste lineari-lanceolatis foliaceis puberulentis marginibus albescentibus glabris, corollis caeruleo-lineatis, tuba corollae 0.5 mm. longa patelliforme, lobis corollae 5.5-7 mm. longis lanceo-ovatis acutis, foveis 1.2-1.3 mm. longis anguste ellipticis marginibus ciliatis, coronis 4-partitis squamis ovalibus 2-3 mm. longis valde lacerato-ciliatis ad apicem, filamentis 5-6 mm. longis, antheris 1.2-1.5 mm. longis anguste oblongis, stylis 3 mm. longis, fructibus ovalibus rostratis 8-10 mm. longis.

CALIFORNIA: Camp Bidwell, [Lassen Co.], 1879, *Dr. W. Matthews* (type in

Ca-Gr); Duncan Horse Camp, Modoc Co., June 30, 1934, *J. T. Howell* 12294 (SF.); Davis Creek, 9 miles south of, Modoc Co., June 12, 1934, *J. T. Howell* 11990 (SF.).

This being a puberulent plant, probably formed part of the concept of *S.* (or *F.*) *albicaulis* of the floras of California. The closest relative, *S. albicaulis* (Griseb.) Kuntze, differs in having the fovea 2.5-5 mm. long, linear lanceolate; the scales of the corona obdeltoid and lacerate hirsute ciliate.

18. **Swertia Watsonii** sp. nov.

Frasera albicaulis sensu Rydb., N. Y. Bot. Gard., Mem. **1**:310, 1900, not Griseb. (1838).

Leucocraspedum albicaule (Dougl.) [=Griseb.] Rydb., Fl. Rocky Mts. 665, 1065, 1917, not *F. albicaule* Griseb.

Perennial from a woody tap-root 3-6 mm. in diameter; crowns of the root with 2-3 fertile shoots and some sterile shoots; stems 15-37 cm. tall; herbage puberulent; leaves opposite; basal and lower leaves not very numerous 3-11 cm. long, 3-4 mm. wide linear or slightly spatulate-linear, white margined; cauline leaves in two pairs, 2.5-4 cm. long, 2 mm. wide, linear; inflorescence 3-8 cm. long, a loose, interrupted cylindric thyrse; floral bracts lance-linear, all but the lowest shorter than the peduncles; pedicels 2-5 mm. long; flowers 4-merous; calyx lobes 4-5 mm. long, linear-lanceolate, nearly distinct, the back puberulent, green and foliaceous, the broad membranous margins glabrous; corolla apparently bluish; corolla tube 0.5 mm. long, saucer-shaped; corolla lobes 5-6 mm. long, lanceolate, each with a fovea 0.5-0.6 mm. long, oblong, closely covered by the long hirsute ciliations of the margin, the closed base 1 mm. long, fused with the base of the corolla lobes; corona of 4 separate scales 2-2.5 mm. long, obovate, deeply lacerate ciliate at the apex; filaments 4 mm. long; anthers 1.5 mm. long, oblong-elliptic; style 3 mm. long, fruit unknown.

Perennis puberulenta, radice lignosa 3-6 mm. diametro, caulibus plurimis 15-37 cm. altis, foliis oppositis radicalibus inferioribusque paucis 3-11 cm. longis 3-4 mm. latis linearibus vel parve spatulato-linearibus albi-marginatis, foliis caulinis 2.5-4 cm. longis, 2 mm. latis linearibus, thyrsis 3-8 cm. longis laxis interruptis, bracteis lanceo-linearibus superis quam pedunculum brevioribus, pedicellis 2-5 mm. longis, floribus 4-partitis, lobis calycorum 4-5 mm. longis lineari-lanceolatis subdistinctis viridibus foliaceis puberulentis marginibus latis membranaceis glabris, tuba corollae 0.5 mm. longa patelliforme, lobis corollae 5-6 mm. longis lanceolatis, foveis 0.5-0.6 mm. longis oblongis marginibus ciliatis, coronis 4-partitis squamis 2-2.5 mm. longis obovatis valde laceratociliatis ad apicem, filamentis 4 mm. longis, antheris 1.5 mm. longis oblongo-ellipticis, stylis 3 mm. longis, fructibus ignotis.

MONTANA: Battleground, Big Hole Valley, (Beaverhead Co.), July 24, 1880, *S. Watson* 269 (type in Ca.-Gr.; also isotypes in Ph; US).

The closest relative is *S. californica* St. John which differs by being much coarser and larger, the leaves 6-12 mm. wide, spatulate; pedicels 3-22 mm. long; calyx lobes 5-7 mm. long; and the fovea 1.2-1.3 mm. long, narrowly elliptic. This collection of *S. Watsonii* was determined as *Frasera albicaulis*

and was the only record of that species in Montana or in the area of Rydberg's Flora of the Rocky Mountains.

19. **Swertia Bethelii** sp. nov.

Perennial from a brown tap-root 4-6 mm. in diameter; crown of root bearing several shoots, 2-4 fertile and one or more sterile ones; herbage sparsely puberulous, more remotely so above; stems 33-35 cm. tall; leaves opposite, all but the lowest blade-bearing; principal basal and lower cauline leaves several, erect, 7-15 cm. long, 4-5 mm. wide, linear, subacute, strongly 3-nerved, chartaceous, apparently yellowish or pale green, with a prominent white margin; upper leaves 2.5-6 cm. long, 3.5-5 mm. wide, linear; inflorescence in anthesis 4-7 cm. long, a cylindric, loose, somewhat interrupted, remotely and minutely puberulous thyrse; floral bracts linear, green and foliaceous, all but the lowest shorter than the pedicels; pedicels 5-10 mm. long; flowers 4-merous; calyx lobes 4-5.5 mm. long, nearly distinct, lanceolate, remotely minutely puberulous to subglabrous, green and foliaceous except for the narrow white membranous margin; corolla apparently pale bluish; corolla tube 1 mm. long, saucer-shaped; corolla lobes 8-9 mm. long, oval, each bearing a fovea 2 mm. long, linear, hirsute ciliate all around the margin, the closed base fused to the base of the corolla lobe for 2 mm.; corona of 4 single, subulate setae 1.5 mm. long; filaments 6-7 mm. long, subulate; anthers 1.8-2 mm. long, linear-elliptic, deeply cleft at base; ovary glabrous; fruit unknown.

Perennis sparse puberulenta, radice 4-6 mm. diametro, caulibus 33-35 cm. altis, foliis oppositis infimis inferioribusque erectis 7-15 cm. longis 4-5 mm. latis linearibus subacutis arcte trinervatis chartaceis albi-marginatis, foliis superis 2.5-6 cm. longis 3.5-5 mm. latis linearibus, thyrsis 4-7 cm. longis cylindraceis minute sparse puberulentis, bracteis linearibus foliaceis, pedicellis 5-10 mm. longis, floribus 4-partitis; lobis calycorum 4-5.5 mm. longis subdistinctis lanceolatis foliaceis margine membranaceo, corollis pallide caeruleis; tuba corollae 1 mm. longa patelliforme, lobis corollae 8-9 mm. longis ovalibus, foveis 2 mm. longis linearibus hirsuti-ciliatis, squamis 4 subulatis 1.5 mm. longis, antheris 1.8-2 mm. longis lineari-ellipticis, fructibus ignotis.

CALIFORNIA: Fall River Mills, Shasta Co., May 17, 1923, *Ellsworth Bethel*, in part, that is the two sparsely puberulous plants on the right-hand side of the sheet, (type in SF.).

The new species *S. Bethelii* occurs in the Sierra Mountains along the Pitt River, California. It is most similar to *S. albicaulis* of the Pacific Northwest, but the latter species differs in being generally puberulent; the crown scales 2-4 mm. long, obdeltoid and lacerate or cleft into numerous setae; and the leaves linear-oblanceolate and broader.

20. **Swertia columbiana** sp. nov.

Frasera nitida sensu Piper, U. S. Nat. Herb., Contr. **11**:452, 1906, and sensu Card as to Washington specimens, Mo. Bot. Gard., Ann. **18**:267-268, 1931, not of Benth. (1849).

Perennial from a dark woody tap-root 3-10 mm. in diameter; shoots

several, glabrous, 41-47 cm. tall, usually one fertile and one or more sterile; leaves opposite, the basal and lowest reduced to sheaths or bracts; median leaves 12-17 cm. long, 6-14 mm. wide, linear-spatulate to linear and acute, firm, 3-nerved, puberulous along the midrib above, white-margined; upper leaves smaller, gradually reduced to bract-like ones at the base of the inflorescence; inflorescence a glabrous narrow, interrupted, racemose cyme (thyrse), 7-20 cm. long in flower, 21 cm. long in fruit; floral bracts linear, reduced, the upper shorter than the pedicels; in anthesis the lower peduncles not elongate, so the 4-merous flowers appear in globose interrupted clusters at the lower nodes; pedicels 5-11 mm. long, calyx lobes 5-6.5 mm. long, nearly distinct, lanceolate, firm, greenish, with pale thin margins; corolla pale blue; corolla tube 0.5 mm. long, saucer-shaped; corolla lobes 5.5-7.5 mm. long, oval, acute, each bearing a single fovea 1.5-2 mm. long, elliptic, the margin densely hirsute with incurved hairs, the base covered and fused to the corolla lobe; corona of 4 separate petaloid scales 3.5-4 mm. long, obovate, with a few shallow apical lacerations; filaments 5-6 mm. long; anthers 2.2-2.6 mm. long, narrowly ellipsoid; ovary with style 2 mm. long; capsule 9-11 mm. long, oval, beaked by the style; seeds 6-9 mm. long, 2-2.5 mm. wide, flattened, elliptic or obliquely so, brown, the testa subpapillose cellular.

Perennis, caulibus pluribus 41-47 cm. altis, glabris, foliis oppositis inferioribus bracteosis mediis 12-17 cm. longis 6-14 mm. latis lineari-spatulatis vel linearibus acutisque trinervatis albi-marginatis costis puberulentis, foliis superioribus diminuatis, inflorescentiis 7-20 cm. longis thyrsoideis, bracteis linearibus, pedicellis 5-11 mm. longis, lobis calycis 5-6.5 mm. longis lanceolatis firmis viridibus marginibus albescentibus tenuibus, corollis pallide caeruleis, tubis 0.5 mm. longis patelliformibus, lobis 5.5-7.5 mm. longis ovalibus acutis, foveis 1.5-2 mm. longis ellipticis marginibus dense hirsuti-ciliatis, coronis 4-partitis squamis 3.5-4 mm. longis petaloideis obovatis ad apicem parce laceratis, filamentis 5-6 mm. longis, antheris 2.2-2.6 mm. longis anguste ellipsoideis, capsulis 9-11 mm. longis ovalibus rostratis.

WASHINGTON: Klickitat County, May 27, August 1881. *W. N. Suksdorf* 40 (type in Ca-Gr.); Mt. Adams, Morrison Creek, open grassy glades, 3300 ft. July 2, 1924, *M. W. Gorman* (Ph.); upper Naches, Cascade Mts., June 1930, *J. M. Grant* 8353 (US.), also the same without number (Berk.); south of Mt. Adams, Cascade Mts., August 6, 1894, *F. E. Lloyd* (NY.); Trout Lake, Klickitat Co., June 1923, *C. A. Pearson* 405 (WSC.); Klickitat River, July 15, 1899, *J. B. Flett* 1023 (WSC.); Satus Park T.8N. R. 16E., Yakima Co., overgrazed timber, 3500 ft. July 6, 1932, *V. Heidenreich* 185 (WSC.); Bickleton, June 29, 1930, *M. E. Jones* 25485 (SF.); Bingen, Klickitat Co., *W. N. Suksdorf* (Berk.). OREGON: Dalles, 1860, *Lyall* (Ca-Gr.); Dalles of the Columbia, spring of 1855, *Suckley* (Ca-Gr, NY.); dry soil, The Dalles, May 7, 1906, *J. Lunnell* (US.); Wasco Co., dry ground, summit of old road between Mosier, May 27, 1928, *J. W. Thompson* 4319 (Ph; US.); Rowena Point, moist flats, May 20, 1924, *M. W. Gorman* x (Ph.); Wasco Co., Dalles, May 23, 1910, *A. A. Heller* 10087 (Ph.); Eight Mile Creek, Mt. Hood National Forest, Wasco Co., yellow pine woods, July 15, 1933, *C. N. Jones* 4070 (SF.); Mt. Hood region, June 1920, *E. P. Hawyer* (SF.); Eastern Oregon, dry prairies, July 1880, *T. J. Howell* (NY; U.Pa.); Grizzly Butte, alt. 840 meters, Crook Co., June 14, 1894, *J. B. Leiberg* 227 (US.); 15 miles west of Maupin, along dry water course, elev. 2000 ft., Wasco Co., June 20, 1939, *C. L. Hitchcock & J. S. Martin* 4806 (NY; WSC.); rocky slopes of Wallowa Mts., near Cornucopia, Baker Co., July 18, 1936, *J. W.*

Thompson 13354 (NY; SF.); Barlow Gate near Mt. Hood, Cascade Mts., July 24, 1894, *F. E. Lloyd* (NY.); Hood River, just east of, Hood River Co., open hilltop with Toxicodendron, Pinus ponderosa, Quercus Garryana, 200 ft., alt., corallas pale blue to white, May 25, 1940, *L. Constance & A. A. Beetle* 2666 (Berk.).

The related *S. nitida* (Benth.) Jepson differs in having the foliage glabrous, the fovea 2 mm. long, oblong, the margin hirsutulous, and the scales of the corona 1.5-2 mm. long, obdeltoid to oblanceolate, shallowly few lobed or somewhat lacerate; and the corolla lobes pale bluish, purple dotted within.

The new species is named for the valley of the Columbia River, where it grows.

20a. Forma **albida** (Suksdorf) comb. nov.

Frasera nitida Benth. var. *albida* Suksd., Werdenda **1**:30, 1927.

This is an albino, a form with white flowers, occurring rarely with the species.

WASHINGTON: on mountains east of Husum, Klickitat Co., June 18, 1923, *W. Suksdorf* 11458 (type WSC; isotypes Ca-Gr; NY; SF.).

21. **Swertia idahoensis** sp. nov.

Perennial with dark brown woody tap-root 7-15 mm. in diameter; shoots several, one or more being fertile, 53-62 cm. tall; leaves opposite, only the lowest pair reduced to scales, the others bearing well developed blades; lower leaves few, not tufted; principal lower and middle leaves 14-19 cm. long, 9-17 mm. wide, linear-spatulate, firm chartaceous, 3-nerved, puberulous along the midrib above, white margined; upper leaves reduced to the base of the inflorescence; inflorescence a glabrous thyrse, in anthesis 12-30 cm. long, interrupted but the flower clusters at the lower nodes rather sparse; floral bracts lanceolate, shorter than the peduncles, the upper ones reduced; pedicels 6-13 mm. long; flowers 4-merous; calyx lobes 6-7 mm. long, nearly separate, lanceolate, green and herbaceous, with white membranous margins; corolla very pale blue; corolla tube 0.3 mm. long, saucer-shaped; corolla lobes 7-7.5 mm. long, ovate-lanceolate, acute, each bearing a single fovea 3 mm. long, lance-linear, the margin closely white hirsute, the closed base fused to the base of the corolla lobe; corona of 4 scales 3-4 mm. long, elliptic at tip deeply lacerate-fimbriate; filaments 5-5.5 mm. long; anthers 1.3-1.6 mm. long, ellipsoid or narrowly so; ovary with style 1-2 mm. long; capsule oval, beaked, the body 10-14 mm. long.

Perennis, radice lignosa brunnea 7-15 mm. diametro, caulibus plurimis 53-62 cm. altis, foliis oppositis infimis reductis reliquis laminiferis, foliis mediis inferioribusque principalibus 14-19 cm. longis 9-17 mm. latis lineari-spatulatis firme chartaceis trinervatis albi-marginatis costa supra puberulosa, foliis superis reductis, thyrsis glabris 12-30 cm. longis interruptis, bracteis lanceolatis quam pedunculum brevioribus superis reductis, pedicellis 6-13 mm. longis, floribus 4-partitis, lobis calycorum 6-7 mm. longis lanceolatis viridibus herbaceis subdistinctis marginibus albis membranaceis, tuba corollae 0.3 mm. longa patelliforme, lobis 7 mm. longis ovato-lanceolatis acutis, foveis 3 mm. longis lanceolinearibus marginibus albi-hirsutis, coronis 4-partitis squamis 3-4 mm. longis

ellipticis ad apicem lacerato-fimbriatis, filamentis 5-5.5 mm. longis, antheris 1.3-1.6 mm. longis ellipsoideis vel anguste ellipsoideis, stylo 1-2 mm. longo, fructibus rostratis ovalibus 10-14 mm. longis.

IDAHO: dry stony hills near Cuprum, July 10, 1899, *W. C. Cusick* 2226 (type in Ca-Gr; isotypes in Berk; NDe; US.); in clumps on a moist hillside, 4 miles north of New Meadows, Adams Co., June 9, 1936, *R. C. Rollins* 1140 (Ca-Gr; NY.); open south slopes, 3000 ft., ½ miles north of Starkey, Adams Co., May 29, 1937, *L. Constance* 1862 (US; Berk.); Black Lake to Bear P. O., Seven Devils Mts., Adams Co., 4500-8000 ft. elev., July 20, 1931, *E. C. Johnston* (SF.). These three localities are within a few miles of each other, all in Adams County, and on the slopes of the Seven Devils Mountains.

The closely related *S. albicaulis* (Griseb.) Kuntze differs in being generally puberulent and in having the fovea linear-oblanceolate, hirsute ciliate almost to the tip; and the scales of the corona obdeltoid, sharply lacerate hirsute ciliate; corolla blue; the lower leaves and those of the sterile shoots numerous, tufted.

22. **Swertia Cusickii** (Gray) comb. nov.

Frasera Cusickii Gray, Am. Acad., Proc. **22**:310, 1887.
F. coerulea Mulford, Bot. Gaz. **19**:118-119, 1894.
F. nitida Benth. var. *Cusickii* (Gray) Nels. & Macbr., Bot. Gaz. **61**:33, 1916; also by Card, Mo. Bot. Gard., Ann. **18**:270, 1931.

It has the fovea elliptic, hirsute ciliate, 1.8-2.2 mm. long, elliptic. The scales of the corona are 3-4 mm. long, petaloid, oval to nearly orbicular, and entire. The herbage is glabrous.

It occurs in Oregon and Idaho. The following localities have not been cited before.

IDAHO: in yellow pine, 5000 ft., McCall, Valley Co., July 4, 1937, *L. Constance* 1945 (US.); sandy knoll, elev. 4500 ft., Cascade, July 22, 1932, *J. N. Christ* 1750 (US.); near Sawtooth, July 30-31, 1896, *B. W. Evermann* 666 (US.); without locality, 1895, *L. F. Henderson* 3056 (US.); on slopes, Barlow Creek, Sawtooth National Forest, July 31, 1909, *C. N. Woods & I. Tidestrom* 2622 (US.). OREGON: Mill Creek, Burns, hillsides in open yellow pine woods, Harney Co., May 31, 1927, *L. F. Henderson* 8679 (SF.).

23. **Swertia lassenica** sp. nov.

Perennial from a yellowish tap-root 4 mm. in diameter; crown of root bearing one leafy and two fertile shoots; herbage glabrous; stems 20-23 cm. tall; leaves opposite, all blade-bearing, the first few pairs much reduced; principal basal and lower cauline leaves few, erect, 3-7 cm. long, 2-7 mm. wide, spatulate, firm chartaceous, 3-nerved, with a prominent white margin; upper leaves 2-4.5 cm. long, 2-3.5 mm. wide, linear spatulate; inflorescence in anthesis 25-40 mm. long, a moderately dense ovoid, glabrous thyrse; floral bracts lanceolate, green, the lower about equaling the pedicels; pedicels 2-8 mm. long; flowers 4-merous, glabrous; calyx lobes 4-5 mm. long, nearly distinct, lanceolate or narrowly so, green and foliaceous except for the white thin margins; corolla bluish; corolla tube 0.2 mm. long, saucer-shaped; corolla lobes 5-5.8 mm. long, oval, acute, each bearing a fovea 1 mm. long, narrowly oblong, hirsute ciliate except at the blunt, open tip, the closed base fused to the base of the corolla lobe for 0.5

mm.; corona of 4 separate scales 0.3 mm. long, elliptic, entire; filaments 2-3 mm. long, subulate; anthers 1.9-2 mm. long, narrowly elliptic-oblong; ovary glabrous; style not equaling the corolla; fruit unknown.

Perennis glabra, radice lignosa lutea 8 mm. diametro, caulibus 20-23 cm. altis, foliis oppositis infimis inferioribusque maximis paucis erectis 3-7 cm. longis 2-7 mm. latis spatulatis firme chartaceis trinervatis albi-marginatis, foliis superis 2-4.5 cm. longis 2-3.5 mm. latis lineari-spatulatis, thyrsis 25-40 cm. longis ovoideis, bracteis lanceolatis foliaceis, pedicellis 2-8 mm. longis, floribus 4-partitis, lobis calycorum 4-5 mm. longis subdistinctis lanceolatis vel anguste lanceolatis foliaceis marginibus albi-membranaceis, corollis caeruleis, tuba corollae 0.2 mm. longa patelliformе, lobis corollae 5-5.8 mm. longis ovalibus acutis, foveis 1 mm. longis anguste oblongis marginibus ciliatis apice nudo, squamis 0.3 mm. longis ellipticis integris, filamentis 2-3 mm. longis subulatis, antheris 1.9-2 mm. longis anguste elliptici-oblongis, fructibus ignotis.

CALIFORNIA: Willow Springs, 1½ mile S. E. of, T.35N., R.6E., 4500 ft. alt., scattered in sage and yellow pine on shallow clay, Lassen National Forest, Lassen County, May 16, 1915, *A. G. Brenneis* 6 (type in Berk.).

This is represented by only a single specimen, but it seems so distinct that it is here described as new. The most similar species is apparently *S. Cusickii* (Gray) St. John of the Blue Mts. of Oregon, but that differs in being a sturdier plant, more leafy; filaments 8-10 mm. long; corolla 9-11 mm. long; fovea 1.8-2.2 mm. long; and the crown scales 3-4 mm. long, oval to subcrbicular.

24. SWERTIA NITIDA (Benth.) Jepson, Man. Fl. Pl. Calif. 766, 1925.

Frasera nitida Benth., Pl. Hartweg. 322, 1849.
S. albicaulis (Griseb.) Kuntze [as Dougl.] var. *nitida* (Benth.) Jepson, Fl. Calif. 3(1):95, 1939.

This species was described from a locality in the mountains of Sacramento, California. Jepson (p. 95) adds that the locality was "almost certainly in Nevada Co." The plant is abundant along the northern Sierra Mts. in California and into southwestern Oregon. It seems to be a uniform and distinct species, having: the corolla 6-8 mm. long, "pale bluish, purple dotted inside" (fide Jepson, Manual p. 766); the fovea 1.8-2.2 mm. long, elliptic, hirsutulous; the scales of the corona 1.5-3 mm. long obdeltoid to oblanceolate, shallowly few lobed or somewhat lacerate. *S. nitida* does not seem to intergrade with *S. albicaulis* or to grow in the same region, and no reason is obvious for making one a variety of the other.

There are two isotypic specimens in the New York Botanical Garden Herbarium, Hartweg no. 1833. This number was the holotype cited by Bentham in the original description. One specimen was labeled, apparently by Asa Gray, *F. nitida*, Calif., Hartweg no. 1833. The second specimen of the same number has a printed label headed Ex Herbario Musei Britanici. In pencil is scrawled, *Frasera nitida* Benth., Mexico, Hartweg. It seems obvious that there is an error here, and that the specimen is really a second isotype, Hartweg no. 1833, from the mountains near Sacramento, California.

25. **Swertia Eastwoodae** sp. nov.

Perennial from a yellowish woody tap-root 4-8 mm. in diameter; crown of root bearing several shoots, three specimens each showing one leafy and two fertile shoots: herbage glabrous; stems 35-44 cm. tall; leaves all blade-bearing, the first few pairs much reduced; principal basal and lower cauline leaves few, erect or diverging, 6-17 cm. long, 3-6 mm. wide, firm chartaceous, linear, acute, 3-nerved, with a prominent white margin; upper leaves 3-12 cm. long, 2-3 mm. broad, linear, acute; inflorescence glabrous, in anthesis 3-14 cm. long, a much interrupted thyrse with elongate internodes and semiorbicular flower clusters at the nodes; floral bracts foliaceous, linear, the principal ones exceeding the pedicels; pedicels 4-22 mm. long; flowers 4-merous, glabrous; calyx lobes 4-8 mm. long, nearly distinct, lance-linear, green and foliaceous but the narrow margins white membranous; corolla yellowish or whitish; corolla tube 0.3 mm. long, saucer-shaped; corolla lobes 5-7 mm. long, oval, acute, each bearing a fovea 1-1.8 mm. long, elliptic hirsutulous ciliate all around the margin or naked at tip, the closed base fused to the base of the corolla lobe for 0.5 mm.; corona of 4 separate scales 0.5-1.5 mm. long, lanceolate to obovate, erose to laciniate serrate; filaments 2-5 mm. long, subulate; anthers 1.5-2 mm. long, oblong; pistil glabrous; style exceeding the corolla; capsule beaked by the base of the style, the body 9-11 mm. long, oval, compressed, yellowish brown; seeds 7-8 mm. long, 1.5-2 mm. wide, narrowly oblong-elliptic, trigonous, dark brown, cellular papillose.

Perennis glabra, radice lignosa lutea 4-8 mm. diametro, caulibus paucis 35-44 cm. altis, foliis oppositis infimis inferioribusque maximis paucis erectis vel divergentibus 6-17 cm. longis 3-6 mm. latis firme chartaceis linearibus acutis trinervatis albi-marginatis, foliis superis 3-12 cm. longis 2-3 mm. latis linearibus acutis, thyrsis 3-14 cm. longis valde interruptis, bracteis foliaceis linearibus, pedicellis 4-22 mm. longis, floribus 4-partitis, lobis calycorum 4-8 mm. longis lanceolato-linearibus foliaceis marginibus albis membranaceis, corollis pallide lutescentibus vel albescentibus, tuba corollae 0.3 mm. longa patelliforme, lobis corollae 5-7 mm. longis ovalibus acutis, foveis 1-1.8 mm. longis ellipticis hirsutuli-ciliatis, squamis 0.5-1.5 mm. longis lanceolatis vel obovatis erosis vel laciniato-serratis, filamentis 2-5 mm. longis subulatis, antheris 1.5-2 mm. longis oblongis, capsulis rostratis 9-11 mm. longis ovalibus compressis luteo-brunneis; seminibus 7-8 mm. longis 1.5-2 mm. latis anguste oblongo-ellipticis triangularibus brunneis papillosis.

CALIFORNIA: Castle Lake, Siskiyou Co., July 24, 1921, *A. Eastwood* 10711 (type in SF.); Cantara, Siskiyou Co., July 23, [1912], *A. Eastwood* 1335 (SF.); Cantara, Siskiyou Co., August 28, 1912, *A. Eastwood* 1945 (SF.); south side, Shaft-rock, Mt. Hilt, Siskiyou Co., *C. P. Rixford* (SF.).

This species occurs in northern California, which is one of the centers of distribution of the genus.. The species is certainly most closely related to a species also abundant in the same general region, *S. nitida* (Benth.) Jepson. The latter species is similar in appearance and has the same interrupted inflorescence, but it differs in having a larger fovea, 1.8-2.2 mm. long; the crown scales 1.5-3 mm. long, and the corolla is pale bluish with purple dots or streaks.

This new species is named in tribute to my good friend, Miss Alice Eastwood, Curator of Botany, California Academy of Sciences, in recognition of her devoted service to botany and of her superior personal qualities.

Abbreviations for the names of herbaria are used in the citation of specimens. These are the standardized abbreviations proposed by J. Lanjouw (Chronica Botanic 3:345-349, 1937). Additional ones used are the following:

LA. — Los Angeles Museum, Los Angeles, California.
NDe. — University of Notre Dame, Notre Dame, Indiana.
U.Pa. — University of Pennsylvania, Philadelphia, Pa.
WSC. — State College of Washington, Pullman, Washington.

American Species to be Excluded from Swertia

Swertia americana Spreng., Syst. Veg. ed. 16, 1:861, 1825, in larger part and as to first synonym = *Halenia deflexa* (Sm.) Griseb., Gen. et Sp. Gent. 324, 1839; in smaller part and as to second synonym =*Halenia gracilis* (HBK.) G. Don, Gen. Syst., 4:177, 1837.

S. asclepiadea HBK., Nov. Gen. et Sp. 3:175-176, 1818 =HALENIA ASCLEPIADEA (HBK.) G. Don, Gen. Syst. 4:177, 1837.

S. brevicornis HBK., Nov. Gen. et Sp. 3:174, 1818 =HALENIA BREVICORNIS (HBK.) G. Don., Gen. Syst. 4:177, 1837.

S. corniculata L., Sp. Pl., ed. 1, 1:227, 1753 =HALENIA DEFLEXA (Sm.) Griseb., Gen. et Sp. Gent. 324, 1839.

S. cucullata Sessé & Moc., Fl. Mex., ed. 2, 73, 1894 =*Halenia brevicornis* (HBK.) G. Don., Gen. Syst. 4:177, 1837.

S. deflexa Sm., in Rees Cyclop, 34, Swertia no. 8, (1819) =1816. =HALENIA DEFLEXA (Sm.) Griseb. Gen. et Sp. Gent. 324, 1839.

S. difformis L., Sp. Pl., ed. 1, 1:226, 1753 =SABATIA DIFFORMIS (L.) Druce, (as *Sabbatia*) Bot. Exch. Club, Rept. 1913: 3(5):423, 1914 (valid name of plant formerly called *Sabbatia lanceolata* (Walt.) T. & G.).

S. gracilis HBK., Nov. Gen. et Sp. 3:176, 1818 =HALENIA GRACILIS (HBK.) G. Don., Gen Syst. 4:177, 1837.

S. hypericoides HBK., Nov. Gen. et Sp. 3:176, 1818 =HALENIA HYPERICOIDES (HBK.) G. Don., Gen. Syst. 4:177, 1837.

S. Michauxiana Schult., Syst. Veg., 6:130, 1820 =HALENIA DEFLEXA (Sm.) Griseb., Gen. et Sp. Gent. 324, 1839.

S. parviflora HBK., Nov. Gen. et Sp. 3:174-175, 1818 =HALENIA BREVICORNIS (HBK.) G. Don, Gen. Syst. 4:177, 1837.

S. parviflora HBK. var. *α angustifolia* Schlecht. & Cham., Linnaea 5:122, 1830 =HALENIA BREVICORNIS (HBK.) G. Don., Gen. Syst. 4:177, 1837.

S. parviflora HBK. var. *β latifolia* Schlecht. & Cham., Linnaea 5:122, 1830 = HALENIA BREVICORNIS (HBK.) G. Don var. LATIFOLIA (Schlecht. & Cham.) C. K. Allen, Mo. Bot. Gard., Ann. 20:141, 1933.

S. plantaginea HBK. Nov. Gen. et Sp. 3:175, 1818 =HALENIA PLANTAGINEA (HBK.) Griseb., Gen. et Sp. Gent. 327, 1839.

S. pauciflora Humb. & Bonpl. ex Schult., Syst. Veg. 6:135, 1820 =HALENIA PLANTAGINEA (HBK.) Griseb., fide Griseb., Gen. et Sp. Gent. 327, 1839.

S. pinifolia R. & P. in G. Don, Gen. Syst. 4:177, 1837 =HALENIA PINIFOLIA D. Don, in G. Don, Gen. Syst. 4:177, 1837. As the name *S. pinifolia* was printed only in synonymy, it was not validly published, hence cannot be accepted as a name bringing synonym, as it is by C. K. Allen (Mo. Bot. Gard., Ann. 20:185, 1933).

S. pusilla Pursh, Fl. Am. Sept. 1: 101, 1814 =LOMATOGONIUM ROTATUM (L.) Fries, Summa Veg. Scand. sect. post. 554, 1849. Fernald in his revision of the genus *Lomatogonium* (Rhodora 21:194, 1919) accepted this specific combination by Fries as made in Nyman, Conspec. Fl. Eur. 3:500, 1881, but in that place Nyman printed the mere name *L. rotatum* Fr. only in the synonymy of *Pleurogyne rotata* Griseb. which he accepted. It is clear that this is not a valid publication, despite its acceptance by Fernald, Hultén, Krylov, and the Index Kewensis. Fortunately it is now revealed that the same author, Fries, had validly published this combination 32 years previously.

S. quadricornis Willd. ex Schult., Syst. Veg. 6:134, 1820 =HALENIA ASCLEPIADEA (HBK.) G. Don, Gen. Syst. 4:177, 1837.

S. recurva Sm., in Rees Cycl. 34: Swertia no. 9 (1819) =1816 (date fide B. D. Jackson) =HALENIA RECURVA (Sm.) C. K. Allen, Mo. Bot. Gard., Ann. 20:161, 1933.

S. rotata L., Sp. Pl. ed. 1, 1:226, 1753 =LOMATOGONIUM ROTATUM (L.) Fries, Summa Veg. Scand. sect. post. 554, 1849.

S. umbellata R. & P., Fl. Peruv. 3:21, pl. 242(b), 1802 =HALENIA UMBELLATA (R. & P.) Gilg, Fedde Repert. Spec. Nov. 2:53, 1906.

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A Collection of Plants from Louisiana

Donovan S. Correll and Helen B. Correll

This paper presents the results of a botanical collecting trip made in the state of Louisiana from June 26th to August 24th, 1938, and several additional collections of *Cyperus* made in Orleans Parish during September 1937. Consequently, it should not be considered an exhaustive survey of the flora of Louisiana. To the contrary, due to the vicissitudes of collecting, many of the most common species found in Louisiana are not found in the list. The data are presented as a contribution to our knowledge of the flora of Louisiana based on extant specimens which are placed in accessible herbaria.

Several catalogues of the flora of Louisiana have been published, notably those of Riddell and Langlois, as well as a number of less comprehensive papers which include species from the state. However, much of the literature concerning the plants of Louisiana is not founded on actual available specimens but consists of lists of names. Hence, until there are specimens available in herbaria it will be an impossibility for one to arrive at any satisfactory conclusions concerning the true status of the flora of Louisiana. Fortunately, Dr. Clair A. Brown of Louisiana State University is working intensively on the flora of Louisiana and is making large collections throughout the state. Through such industrious workers as Dr. Brown, as well as Dr. W. T. Penfound of Tulane University and others in the state, it should not be long before a comprehensive knowledge of the flora of Louisiana is attained.

A number of the species collected are of particular interest because they represent either range extensions, unusual distribution or are considered to be rare in the state. These species are designated by asterisks (*). It is impractical to discuss each of these exceptional species individually. However, there are several of the flowering plants which deserve special mention.

According to Dr. Palmer, the collection of *Aeschynomene sensitiva*, a Central and South American species, is perhaps the first from the United States. The collection of *Juncus Longii*, according to Dr. Hermann, is the first record outside of Virginia. Also, according to Dr. O'Neill, the collection of *Cyperus pilosus* is the second record from the United States, while the advent and establishment of *Cyperus giganteus* as a component of the flora of Louisiana is of interest but not unusual.

According to our collections, the family *Ericaceae* presents the most interesting distribution of species in Louisiana. In Washington Parish, such northerly species as *Leucothoë axillaris* and *Kalmia latifolia* are found growing in the same ravine with such southern species as *Illicium floridanum*, while *Rhododendron arborescens* is found nearby in the same parish. *Rhododendron nudiflorum* is also found in Webster Parish in the northern part of the state. The two last named species are also supposed to have a more northern distri-

bution than Louisiana. Some of the other species of particular interest are: *Melanthium dispersum, Sisyrinchium Brownei, Ponthieva racemosa, Erythrodes querceticola, Carya laciniosa, Quercus imbricaria, Asarum arifolium, Actaea pachypoda, Asimina parviflora, Gillenia stipulata, Duchesnea indica, Pachysandra procumbens, Cuphea carthagenensis, Hypericum lobocarpum, Ptilimnium costatum, Heliotropium procumbens, Vernonia altissima* and *Chondrophora virgata.*

The family, generic and specific nomenclature of the Spermatophyta is essentially that found in Gray's New Manual of Botany, 7th edition (1908), supplemented where necessary by Small's Manual of the Southeastern Flora (1933). The arrangement of the families and genera also follow that found in Gray's Manual. The nomenclature and sequence of the Hepaticae and Musci is largely that found in the "Special Check List Number" of The Bryologist (vol. 43, No. 5, 1940).

The following citations of species, varieties or forms include 7 Lichens, 40 Hepaticae, 55 Musci and 692 Spermatophyta; making a total of 794. Our collection number follows the parish in which the specimen was collected. The specimens of ferns and fern allies are not cited because they are to be included in a future joint publication with Dr. Clair A. Brown. Except for the Lichens which have been deposited in the Farlow Herbarium of Harvard University, the first set of specimens are to be deposited in the Duke University Herbarium. The second set will be deposited in the Farlow Herbarium and Gray Herbarium of Harvard University. Additional sets of duplicates, where such is available, will be deposited mainly in the Herbarium of the National Arboretum at Washington, the Louisiana State University Herbarium, the New York Botanical Garden Herbarium, the Field Museum Herbarium at Chicago, the Herbarium of the Philadelphia Academy of Natural Sciences, the Missouri Botanical Garden Herbarium and the Herbarium of the University of Notre Dame.

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Lichenes

Peltigeraceae

Peltigera canina (L.) Hoffm. On moist open rock face. Winn Parish (10008A).

Cladoniaceae

Cladonia cristatella Tuck. var. On rotten logs in woods. St. Martin Parish (9443).
Cladonia cristatella Tuck. f. *squamulosa* Robb. Open moist soil. Rapides Parish (9725).

Parmeliaceae

Parmeliopsis pallescens (Neck.) A. Zahlb. On cedar tree. Tangipahoa Parish (9113).

Usneaceae

Ramalina calicaris (L.) E. Fr. On twigs and branches of sycamore trees. Calcasieu Parish (9634).

Usnea florida Wigg. var. *strigosa* Ach. On rotten branch of tree in woods. Lafayette Parish (9412).

Physciaceae

Physcia Leana Tuck. On limb of tree in flooded woodland. Natchitoches Parish (9832).

Bryophyta

Hepaticae

Lepidoziaceae

**Bazzania trilobata* (L.) S. F. Gray. On *Kalmia latifolia* in wooded ravine. Washington Parish (9213 in part).

Calypogeiaceae

**Calypogeia Trichomanis* (L.) Corda. On wet or moist soil in woods. Bossier 10118 in part), Iberia (9485) and West Feliciana (10482) Parishes.

Cephaloziaceae

Cephalozia catenulata (Hüben.) Spruce. On moist soil in woods. Livingston Parish (9149).

**Cephalozia media* Lindb. On moist rock faces or rotten logs in woods. De Soto (10207 in part) and Washington (9183 in part) Parishes.

Odontoschisma prostratum (Sw.) Trevis. On moist sandy soil or dry soil. Livingston (9152) and Natchitoches (9768) Parishes.

Plagiochilaceae

Plagiochila ludoviciana Sulliv. On tree trunks in swamp. Tangipahoa Parish (9299 in part).

Scapaniaceae

Scapania nemorosa (L.) Dumort. On moist or dry soil and rock faces. De Soto (10207 in part), Livingston (9148) and Natchitoches (9770) Parishes.

Porellaceae

Porella pinnata L. On cypress knees, exposed roots, small bushes and base of tree trunks in swampy woods. Lafayette (9411), Livingston (9146, 9155 in part) and Natchitoches (9831) Parishes.

**Porella platyphylla* (L.) Lindb. On surfaces of rock in open. Winn Parish (10013).
**Porella platyphylloidea* (Schwein.) Lindb. On dry surface of rock in open. Winn Parish (10014).

Radulaceae

**Radula australis* Aust. On trunk of *Carpinus* in ravine. Iberia Parish (9489 in part).

Frullaniaceae

**Frullania Brittoniae* Evans. On trunks of *Celtis* in rather dense woods. Rapides (9732) and St. Martin (9387) Parishes.

Frullania Kunzei Lehm. & Lindenb. On trunk of live oak. Iberia Parish (9528).

Frullania squarrosa (R. Bl. & N.) Dumort. On trunks and limbs of magnolia, ash and other trees. Lafayette (9409), Natchitoches (9978), Rapides (9729) and St. Martin (9446) Parishes.

Lejeuneaceae

Leucolejeunia clypeata (Schwein.) Evans. On bushes and trunks or exposed roots of trees in moist woods. Livingston (9153, 9155 in part) and Tangipahoa (9301) Parishes.

**Leucolejeunia conchifolia* Evans. On trunk of live oak trees. Tangipahoa Parish (9115).

Leucolejeunia unciloba (Lindenb.) Evans. On trunk of *Celtis* in low woods. Rapides Parish (9733).

Euosmolejeunia duriuscula (Nees) Evans. On tree trunks in wooded ravines and swamps. Tangipahoa (9299 in part) and Washington (9210) Parishes.

**Lejeunia cladogyna* Evans. On slope of moist wooded ravine. West Feliciana Parish (10948).

**Lejeunia flava* (Sw.) Nees. On trunk of live oak tree. St. Martin Parish (9439).

Microlejeunia laetevirens (Nees & Mont.) Evans. On trunk of live oak tree, Tangipahoa Parish (9116).

**Microlejeunia ulicina* (Tayl.) Evans. On *Kalmia latifolia* in wooded ravine. Washington Parish (9213 in part).

Fossombroniaceae

**Fossombronia foveolata* Lindb. In mud on ledge of hidden drip-rock. Natchitoches Parish (9767).

Pelliaceae

**Pellia Fabroniana* Raddi. In mud and on base of trees along wooded ravines. Lincoln (10355) and (?) Washington (9202) Parishes.

Pallaviciniaceae

Pallavicinia Lyellii (Hook.) S. F. Gray. On mud and exposed roots or rocks in swampy woods and along streams. Bossier (10239), Caddo (10157), Calcasieu 9662), Livingston (9126, 9154 in part), Natchitoches (9771) and Washington (9206) Parishes.

Metzgeriaceae

**Metzgeria myriopoda* Lindb. On trunks of trees in swamps and wooded ravines. Iberia (9489 in part) and Tangipahoa (9299 in part) Parishes.

Riccardiaceae

**Riccardia latifrons* Lindb. On moist bank of wooded ravine. West Feliciana Parish (10491).

Riccardia multifida (L.) S. F. Gray. On rotten logs and stumps in streams and wooded ravines. Rapides (9867) and Washington (9204, 9208) Parishes.

**Riccardia palmata* (Hedw.) Carruth. On rotten logs in small stream under a drip-rock. Natchitoches Parish (9766).

**Riccardia sinuata* (Dumort.) Trevis. In mud on open seepage slope and on rotten logs and wet rock faces in woods. Bossier (10229), Natchitoches (9984), Washington (9183 in part) and Winn (10022) Parishes.

Marchantiaceae

**Marchantia domingensis* Lehm. & Lindenb. On wet or moist soil in woods and in shaded places. Tangipahoa (9298) and West Feliciana (10426, 10485) Parishes.

Conocephalum conicum (L.) Dumort. Moist bank of dry stream. West Feliciana Parish (10407).

Dumortiera hirsuta (Sw.) Nees. Moist soil of deep wooded ravine. Iberia Parish (9490, 9514).

**Dumortiera nepalensis* (Tayl.) Nees. On moist wooded ravine slopes. West Feliciana Parish (10429, 10478).

Reboulieaceae

Reboulia hemisphaerica (L.) Raddi. On moist or wet soil and rocks in ravines and

along streams. Bossier (10118 in part, 10228), Natchitoches (9833), St. Martin (9390) and Winn (10015) Parishes.

Ricciaceae

Riccia fluitans L. On mud in open. Caddo Parish (10155).

Riccia membranacea Gottsche & Lindenb. In mud of swampy woods. Caddo Parish (10158 in part).

**Riccia Sullivantii* Aust. In mud of swampy woods. Caddo Parish (10158 in part).

Anthocerotaceae

Anthoceras carolinianus Michx. On wet soil and rocks or exposed roots in wooded ravines or swampy woods. Bossier (10233), De Soto (10204), Livingston (9215, 9154 in part), Natchitoches (9834) and West Feliciana (10492) Parishes.

Anthoceros laevis L. On mud or wet rock faces. Rapides (9872) and (?) West Feliciana (10483) Parishes.

MUSCI

Sphagnaceae

**Sphagnum cuspidatum* Ehrh. var. *Torreyi* (Sull.) Braithw. On edge of pocosin Tangipahoa Parish (10503).

**Sphagnum cyclophyllum* Sull. & Lesq. On mud of savannah. Tangipahoa Parish (10531).

Sphagnum imbricatum Hornsch. In boggy soil and on wooded seepage slopes, or in pocosins. Bienville (10055), Bossier (10240), Claiborne (10335), De Soto (10173), Natchitoches (9750, 9801A, 9977), Ouachita (10363), Rapides (9876), Tangipahoa (10501), Washington (9211), Winn (10046) and Webster (10271, approaching var. *affine* (Ren. & Card.) Warnst.) Parishes.

**Sphagnum macrophyllum* Bernh. In mud of pocosin. Tangipahoa Parish (10500).

Sphagnum palustre L. In swampy or low moist woods or on seepage slopes. Bossier (10235), Grant (9738), Natchitoches (9800), Ouachita (10361), Tangipahoa (10504), Washington (9212) and Webster (10272) Parishes.

Sphagnum recurvum Beauv. On wet soil or rotten wood in bogs and low moist woods. Bienville (10056), Bossier (10237), Claiborne (10336) and Washington (9185) Parishes.

Sphagnum subsecundum Nees. In pocosins and boggy woods, on open or wooded seepage slopes or in wet soil on drip-rocks along streams. Bossier (10107, 10238), Caddo (10156), De Soto (10220), Grant (9737), Natchitoches (9772, 9801, 9981), Rapides (9706, 9873), Tangipahoa (10499), Webster (10274) and Winn (10045) Parishes.

Leucobryaceae

Leucobryum albidum (Brid.) Lindb. On rotten wood and moist soil in woods. Livingston (9180), Rapides (9868) and West Feliciana (10408) Parishes.

Ditrichaceae

Ditrichum pallidum (Hedw.) Hampe. On dry or wet soil in forests or in the open. Livingston (9124, 9147), Rapides (9869), St. Landry (9463), Tangipahoa (9262) and West Feliciana (10477) Parishes.

Grimmiaceae

Grimmia sp. On dry open rock surface. Winn Parish (10012).

Tortulaceae

Weisia viridula Hedw. On soil in moist low woods. St. Landry Parish (9464).

**Tortella humilis* (Hedw.) O. E. Jenn. On base of tree trunk. Washington Parish (9209).

Barbula Cruegeri Sond. On wall of pit in old limestone quarry. Winn Parish (10035).

Fissidentaceae

**Fissidens Bushii* Card. & Thér. On face of wet rock along wooded stream. Bossier Parish (10231).

Fissidens polypodioides Hedw. On moist soil in wooded ravines. Livingston (9150) and West Feliciana (10425) Parishes.

**Fissidens Ravenelii* Sull. On dripping soapstone rocks at spring in dense woods. Winn Parish (10021).

**Fissidens taxifolius* Hedw. On moist soil of wooded bank along stream. St. Martin Parish (9388).

Orthotrichaceae

Schlotheimia Sullivantii C. Muell. On tree trunks (particularly magnolias) and rotten wood in dense woods. Livingston (9178), Natchitoches (9983) and Washington (9188) Parishes.

Pterobryaceae

Pireella ludoviciae (C. Muell.) Card. On tupelo gum tree in low woods. Livingston Parish (9179).

Leucodontaceae

Leucodon julaceous (Hedw.) Sull. On base of magnolia tree on edge of swamp. Rapides Parish (9728).

Leptodon trichomitrion (Hedw.) Mohr. On tree trunks in wooded ravines or low moist woods. Iberia (9487) and Natchitoches (9830) Parishes.

Climaciaceae

**Climacium americanum* Brid. In drained low swampy woods. Bossier Parish (10108).

Fontinaleaceae

Fontinalis sp. On rocks in running water of wooded streams. Natchitoches Parish (9982).

Theliaceae

Thelia hirtella (Hedw.) Sull. On moist rock face on edge of woods. Winn Parish (10010).

Leskeaceae

Thuidium delicatulum (Hedw.) Mitt. On moist or wet soil along wooded streams, in mud of cypress swamps and on wet rock faces along streams. De Soto (10206), Ouachita (10358), Webster (10273), West Feliciana (10486 in part) and Winn (10023 in part) Parishes.

Thuidium microphyllum (Hedw.) Best. On rotten log in woods. Lafayette Parish (9413).

Thuidium minutulum (Hedw.) Bryol. Eur. On exposed roots and small rocks in wooded stream. West Feliciana Parish (10484).

Thuidium virginianum (Brid.) Lindb. Base of ash tree. Lafayette Parish (9410).

Leskea australis Sharp. On tree trunks and limbs in low woods. Lafayette (9362) and St. Martin (9444) Parishes.

?*Leskea gracilescens* Hedw. Base of *Celtis* tree trunk along stream. St. Martin Parish (9389).

Anomodon rostratus (Hedw.) Schimp. On moist rock faces on edge of woods. Winn Parish (10009).

Fabroniaceae

Clasmatodon parvulus (Hampe) Sull. On base of magnolia tree on edge of swamp. Rapides Parish (9724).

Entodontaceae

**Entodon Drummondii* (B.S.G.) J. & S. On tree trunks and exposed roots of trees in ravines and swamps. Iberia (9512), Rapides (9726) and Washington (9203) Parishes.

Entodon seductrix (Hedw.) C. Muell. On tree trunks and rotten logs in swamps and low moist woods. Lafayette (9408, 9414), Livingston (9128), Rapides (9730), St. Martin (9441) and Tangipahoa (9300) Parishes.

Amblystegiaceae

Leptodictyum riparium (Hedw.) Warnst. On wet sheltered rock face along wooded stream. Bossier Parish (10224).

Amblystegium varium (Hedw.) Lindb. Moist soil along wooded stream. West Feliciana Parish (10486 in part).

Brachytheciaceae

**Eurhynchium hians* (Hedw.) J. & S. On moist soil or wet rock faces along wooded streams. Bossier (10232) and West Feliciana (10430, 10480, 10486 in part) Parishes.

**Eurhynchium Rappii* (Williams) Grout. On moist soil in deep wooded ravine. Iberia Parish (9488).

Eurhynchium serrulatum (Hedw.) Kindb. On moist soil and rock faces in forests and in the open. Livingston (9151), St. Landry (9462) and Winn (10008) Parishes.

Eurhynchium strigosum (Hoffm.) B. S. G. In sandy soil near stream in woods. Washington Parish (9214 in part).

**Brachythecium oxycladon* (Brid.) J. & S. On moist soil along wooded stream. West Feliciana Parish (10486 in part).

Plagiotheciaceae

**Plagiothecium deplanatum* (Sull.) Grout. In moist soil under rock ledge. Winn Parish (10016).

Plagiothecium micans (Sw.) Paris. On moist soil, rotten logs and exposed wet roots in low moist woods. Livingston (9127), Rapides (9878), St. Martin (9442) and Washington (9187, 9205) Parishes.

**Plagiothecium turfaceum* (Lindb.) Lindb. On wet rock face along wooded stream. Bossier Parish (10230).

Hypnaceae

Sematophyllum adnatum (Michx.) E. G. B. On tree trunks and rotten logs in forests. Rapides (9731), Tangipahoa (9114) and Washington (9207) Parishes.

Mniaceae

Mnium affine Bland. On moist or wet soil of wooded ravines and stream banks. Iberia (9513 in part) and St. Landry (9465) Parishes.

Mnium cuspidatum Hedw. Moist soil along wooded stream. West Feliciana Parish (10486 in part).

Mnium rostratum Schrad. On moist bank along wooded stream. Winn Parish (10023 in part).

Aulacomniaceae

Aulacomnium heterostichum (Hedw.) B. S. G. On thin soil of exposed rock along wooded stream. Bossier Parish (10226).

Aulacomnium palustre Schwaegr. On base of tree trunk in low swampy woods. Bossier Parish (10109).

Funariaceae

Funaria hygrometrica Hedw. Open dry soil in sparsely wooded area. Caddo Parish (10106).

Polytrichaceae

Atrichum angustatum (Brid.) B.S.G. On moist soil in swampy woods or wooded ravines. Iberia (9486, 9513 in part) and Rapides (9727) Parishes.

**Atrichum MacMillani* (Holz.) Frye. On dry or sandy soil in forests or in the open. St. Landry (9461), Washington (9214 in part) and Winn (10020) Parishes.

Pogonatum brachyphyllum (Rich.) Beauv. On wet soil on stream bank in woods. Rapides Parish (9871).

Pogonatum pensilvanicum (Hedw.) Paris. On moist or wet soil along wooded stream banks. West Feliciana (10405) and Winn (10019) Parishes.

Spermatophyta

Pinaceae

**Pinus glabra* Walt. Upland woods. Livingston Parish (9145).

Pinus Taeda L. Open upland soil. De Soto Parish (10164).

Taxodium distichum (L.) L. C. Rich. Swamps and low pasturelands. Bossier (10234) and St. Landry (9467) Parishes.

Juniperus virginiana L. Open flat country, about 4 miles southeast of Logansport. Very large tree: about 85 ft. tall and with a 40 ft. limb spread. De Soto Parish (10169).

Typhaceae

Typha angustifolia L. Wet soil, base of steep embankment. Caddo Parish (10084).

Najadaceae

Potamogeton diversifolius Raf. Floating on small pool on edge of pocosin. Natchitoches Parish (9802).

Alismaceae

**Sagittaria australis* (J. G. Sm.) Small. In seepage on edge of woods. Caddo Parish (10141).

Sagittaria cycloptera (J. G. Sm.) Mohr. In water of shallow ditches. Bossier (10131) and Calcasieu (9591) Parishes.

Echinodorus radicans (Nutt.) Engelm. In seepage and swampy places in woods. Caddo (10135) and Lafayette (9354) Parishes.

Gramineae

**Eragrostis bahiensis* Schrad. In dry or moist soil on edge of marshes or in pasturelands. Cameron (9594) and Iberia (9550) Parishes.

**Eragrostis capillaris* (L.) Nees. Open dry soil on edge of woods. Caddo Parish (10103).

**Eragrostis lugens* Nees. Dry upland pasture. Iberia Parish (9549).

Eragrostis pectinacea (Michx.) Nees. Sandy open soil in flood area of the Red River. Bossier Parish (10067).

Eragrostis refracta (Muhl.) Scribn. In dry sandy scrub oak region. Winn Parish (10034).

Eragrostis reptans (Michx.) Nees. Moist sandy soil along river banks. Bossier (10069) and De Soto (10184) Parishes.

Eragrostis secundiflora Presl. In sandy soil along Holly Beach. Cameron Parish (9605).

Eragrostis spectabilis (Pursh) Steud. Pine-scrub oak sandhills. Rapides Parish (9918).

Uniola latifolia Michx. In mud or moist soil along wooded streams. Livingston (9139) and Rapides (9702) Parishes.

Uniola laxa (L.) B. S. P. In dry pine woods. Livingston Parish (9175).

Uniola ornithorhyncha Steud. In cypress border of savannah. Tangipahoa Parish (9308).

Uniola sessiliflora Poir. In dry pine woods. Livingston Parish (9174).

Triodia flava (L.) Smyth. Burnt-over open pine slope. Rapides Parish (9910).

Triodia stricta (Nutt.) Benth. Dry soil in open fields or on edge of woods and meadows. Caddo (10160) and Rapides (9934) Parishes.

Elymus virginicus L. var. *glabriflorus* (Vasey) Bush. Moist soil of low woodlands and along wooded river bank. Caddo (10092) and De Soto (10187) Parishes.

Avena sativa L. Sandy open soil along the Red River. Bossier Parish (10064).

Sporobolus cryptandrus (Torr.) A Gray. Sandy open soil along the Red River. Bossier Parish (10071).

Sporobolus Poiretii (Roem. & Schult.) Hitchc. Dry open-wooded slope. Rapides Parish (9929).

Aristida lanosa Muhl. In seepage of scrub oak hillside. Natchitoches Parish (9964).

Aristida oligantha Michx. Dry sandy soil in scrub oak region. Winn Parish (10033).

Aristida purpurascens Poir. Dry soil in scrub oak-pine woodlands. Caddo (10105) and Natchitoches (9957) Parishes.

**Leptochloa fascicularis* (Lam.) A. Gray. Edge of high tide along Holly Beach. Cameron Parish (9606).

Leptochloa filiformis (Lam.) Beauv. Open sandy soil and along ditches. Caddo (10267) and Rapides (9997) Parishes.

Eleusine indica (L.) Gaertn. Dry open soil. Lafayette Parish (9366).

Spartina cynosuroides (L.) Roth. Salt marshes, Iberia Parish (9533).

Spartina patens (Ait.) Muhl. Salt marshes. Iberia Parish (9559).

Spartina spartinae (Trin.) Merr. Salt marshes. Cameron Parish (9619).

Ctenium aromaticum (Walt.) Wood. Moist soil of prairies and savannahs. Beauregard Parish (9667).

Gymnopogon ambiguus (Michx.) B. S. P. Open dry fields. Caddo Parish (10159).

Leersia hexandra Sw. Growing in water of shallow ditch. Calcasieu Parish (9633).

Leersia lenticularis Michx. In open swamps or swampy woods. Lafayette (9351), Tangipahoa (9282) and Webster (10301) Parishes.

Leersia virginica Willd. In swampy or rather dry soils in open or in woods. Lafayette (9367) and Livingston (9144) Parishes.

**Digitaria ischaemum* (Schreb.) Muhl. Open dry eroded hillside. Rapides Parish (9941).

Digitaria sanguinalis (L.) Scop. Open dry soil. Tangipahoa Parish (9261).

Brachiaria extensa Chase. Low moist open field. Caddo Parish (10104).

Axonopus compressus (Sw.) Beauv. Dry pine woods. Tangipahoa Parish (10507).

Paspalum ciliatifolium Michx. Dry soil of pinelands. Livingston Parish (9173).

Paspalum conjugatum Bergius. Dry soil of pinelands. Livingston Parish (9176).

**Paspalum debile* Michx. Dry soil of pine-scrub oak sandhills. Rapides Parish (9912).

Paspalum dilatatum Poir. In moist soil or on oyster shell mounds. St. Mary (9345) and Tangipahoa (9269) Parishes.

Paspalum dissectum L. Dry open gravelly soil. Tangipahoa Parish (10529).

Paspalum floridanum Michx. Burnt-over soil in pine-scrub oak sandhills. Rapides Parish (9902).

Paspalum floridanum Michx. var. *glabratum* Engelm. Low moist woods. Webster Parish (10278).

Paspalum laeve Michx. In boggy soil on edge of swampy woods. Bossier Parish (10251).

Paspalum plicatulum Michx. Dry soil of pine-scrub oak sandhills. Rapides Parish (9856).

**Paspalum praecox* Walt. Moist well-drained soil on oyster shell mounds. St. Mary Parish (9344).

Paspalum urvillei Steud. Moist or dry soil along ditches and streams. De Soto (10162) and Lafayette (9384) Parishes.

Panicum aciculare Desv. Dry soil of pine-scrub oak sandhills. Rapides Parish (9864, 9899, 9901).

Panicum agrostoides Spreng. Open place in swampy woods. Lafayette Parish (9353).

Panicum albomarginatum Nash. Dry soil of pine woods. Tangipahoa Parish (9324).

Panicum anceps Michx. Moist open uplands. Iberia Parish (9554).

Panicum angustifolium Ell. Dry soil of pine-scrub oak sandhills and in cut-over pinelands. Natchitoches (9783, 9949) and Rapides (9862, 9893) Parishes.

Panicum arenicoloides Ashe. Dry soil of pine-scrub oak sandhills. Rapides Parish (9901A).

Panicum Boscii Poir. In moist soil of burnt-over pine-hardwood forest. Rapides Parish (9865).

Panicum Boscii Poir. var. *molle* (Vasey) Hitchc. & Chase. Bank of moist wooded ravine. Iberia Parish (9503).

Panicum commutatum Schult. Moist soil in woods. St. Martin Parish (9405).

Panicum consanguineum Kunth. Dry or moist soil in pine-scrub oak regions or cut-over pinelands. Natchitoches (9782, 9973), Rapides (9892) and Tangipahoa (9276) Parishes.

Panicum dichotomum L. Dry soil of pinewood slopes or swamplands. Natchitoches (9741) and Tangipahoa (9283) Parishes.

Panicum dichotomiflorum Michx. Moist soil along ditches and road shoulders. St. Martin (9391) and Tangipahoa (9241) Parishes.

**Panicum flexile* (Gattinger) Scribn. Dry woodlands. Caddo Parish (10097).

Panicum gymnocarpon Ell. Wet soil in swampy woods. Lafayette Parish (9357, 9380).

Panicum hians Ell. Moist soil along ditches and on edge of low swampy woods. Caddo (10154) and East Baton Rouge (10494) Parishes.

Panicum Joorii Vasey. Moist soil in pinelands or pine-hardwood forests. Rapides Parish (9903, 9907, 9921, 9922).

Panicum lanuginosum Ell. Dry or moist soil in pine-scrub oak sandhill regions. Natchitoches (9781) and Rapides (9891, 9908) Parishes.

Panicum leucothrix Nash. Rocky summit of scrub oak sandhill. Natchitoches Parish (9974).

Panicum lucidum Ashe. In seepage on open high hill. Natchitoches Parish (9947).

Panicum microcarpon Muhl. Moist or boggy soil in woodlands. Bossier (10113), Livingston (9122) and Rapides (9917, 9917A) Parishes.

Panicum nitidum Lam. Moist open grassland. Tangipahoa Parish (9272).

Panicum ovinum Scribn. & Smith. Dry soil of pine-scrub oak sandhills or pinelands. Rapides (9862A) and Tangipahoa (9275) Parishes.

Panicum polyanthes Schult. Moist open sandy soil. Natchitoches Parish (9776).

Panicum Ravenelii Scribn. & Merr. Dry soil of pine-scrub oak sandhills or scrub oak regions. Natchitoches (9968) and Rapides (9894, 9906) Parishes.

Panicum sphaerocarpon Ell. Dry soil of pine-scrub oak sandhills, pinelands or fields and in moist soil in prairies and savannahs. Calcasieu (9576), Natchitoches (9950), Rapides (9904, 9905) and Tangipahoa (9260, 9323) Parishes.

Panicum stipitatum Nash. Moist open sandy soil along the Sabine River. De Soto Parish (10188).

Panicum trifolium Nash. Dry soil in pine-scrub oak sandhills. Rapides Parish (9889).

Panicum virgatum L. Dry sandy soil in fields and along saltwater canals. De Soto (10189) and Iberia (9537) Parishes.

Panicum xalapense H. B. K. Dry soil of pine-scrub oak sandhills, pinewoods slopes, cut-over woodlands and moist open-wooded slopes. Iberia (9519), Livingston (9123), Natchitoches (9472), Rapides (9909) and West Feliciana (10466) Parishes.

Oplismenus setarius (Lam.) Roem. & Schult. Moist woodlands and ravines. Iberia

(9526) and St. Tammany (8491) Parishes.

Echinochloa colonum (L.) Link. Moist soil on shell mounds and under railroad trestles. Lafayette (9365) and St. Mary (9342, 9343) Parishes.

Echinochloa crusgalli (L.) Beauv. Saltmarsh along canal. Iberia Parish (9555).

Setaria lutescens (Weigel) F. T. Hubb. In moist or wet sandy soils or swampy soils. Bossier (10075), Rapides (9838) and Tangipahoa (9246) Parishes.

Setaria magna Griseb. Edge of open marshlands. Cameron Parish (9593).

**Cenchrus echinatus* L. Sandy soil on roadshoulders. Ouachita Parish (10357).

Cenchrus pauciflorus Benth. Sandy soil along beaches, rivers and roadshoulders and in pine-scrub oak regions. Bossier (10070), Cameron (9616), Claiborne (10343), Natchitoches (9985) and Rapides (9930) Parishes.

Erianthus contortus Ell. Moist open soil and dry sandy soil. Bossier (10129) and De Soto (10183) Parishes.

Andropogon furcatus Muhl. Dry open soil on edge of woods. Claiborne Parish (10346).

**Andropogon saccharoides* Sw. Dry open soil along road. Lafayette Parish (9383).

Andropogon tener (Nees) Kunth. In seepage on open hillside. Natchitoches Parish (9965).

Andropogon ternarius Michx. In open dry field. Caddo Parish (10102).

Sorghum vulgare Pers. var. *sudanense* (Piper) Hitchc. Open fields. Tangipahoa Parish (9245).

Cyperaceae

Cyperus articulatus L. Edge of saltwater canal. Iberia Parish (9531).

Cyperus cephalanthus Torr. & Hook. In wet ditch along road. Lafayette Parish (9435).

Cyperus erythrorhizos Muhl. In water of ditch along road. Orleans Parish (8487).

Cyperus filiculmis Vahl. Summit of dry sandy rocky scrub oak sandhill. Natchitoches Parish (9969).

Cyperus flavescens L. In mud of small open streams. Winn Parish (10044).

**Cyperus giganteus* Vahl. Low wet soil on edge of lake, Avery Island. Iberia Parish (9546).

Cyperus globulosus Aubl.. Moist open grassy soil. Caddo (10082) and Lafayette (9356, 9438) Parishes.

Cyperus Haspan L. In water of shallow ditch in field. Calcasieu Parish (9646).

Cyperus Iria L. Moist or wet soil in fields and along ditches. Calcasieu (9645) and St. Mary (9335) Parishes.

Cyperus odoratus L. In saltmarshes, along beaches and on flood areas of rivers. Bossier (10077), Cameron (9614) and Iberia (9558) Parishes.

Cyperus ovularis (Michx.) Torr. Dry or wet soil in open or in pine-hardwood forests. Caddo (10080), Lafayette (9438A) and Rapides (9919) Parishes.

**Cyperus pilosus* Vahl. In water of ditch along road, 3 miles east of Robert. Tangipahoa Parish (10528).

Cyperus polystachyos Rottb. var. *filicinus* (Vahl) O'Neill. In salt marsh. Iberia Parish (9564).

Cyperus polystachyos Rottb. var. *leptostachyus* Boeckl. In salt marsh. Iberia Parish (9541).

Cyperus pseudovegetus Steud. In wet soil of ditches. St. Martin (9449A) and Tangipahoa (9325) Parishes.

Cyperus refractus Engelm. Summit of dry sandy rocky scrub oak hill. Natchitoches Parish (9967).

Cyperus retrofractus (L.) Torr. In dry soils of exposed hillsides and in pine-scrub

oak regions or cut-over pinelands. Bossier (10122), Natchitoches (9759), Rapides (9853) and Webster (10313) Parishes.

Cyperus retrorsus Chapm. In wet soil along ditches. Orleans Parish (8489).

Cyperus rotundus L. Moist or dry soil in fields, along railroad tracks and in flood areas of rivers. Bossier (10074), Calcasieu (9624) and St. Mary (9339) Parishes.

Cyperus strigosus L. Moist or wet soil along ditches, in depressions, margin of swamps and wooded ravines. Claiborne (10344), Lafayette (9434), Orleans (8488), St. Charles (9332), St. John the Baptist (9331), St. Martin (9459), Tangipahoa (9248) and West Feliciana (10409) Parishes.

Cyperus thyrsiflorus Schlectend. & Cham. In wet or moist soil along ditches and in bushes along streams. Orleans (8486) and St. Martin (9404) Parishes.

Cyperus virens Michx. In mud or wet soil of salt marshes, ditches and swamps. East Baton Rouge (9119), Iberia (9563), Lafayette (9371), St. Martin (9449) and Tangipahoa (9326) Parishes.

Eleocharis albida Torr. Edge of saltwater canal. Iberia Parish (9548).

Eleocharis microcarpa Torr. In mud of open ditch. Tangipahoa Parish (9321).

Eleocharis tuberculosa (Michx.) R. & S. In wet soil of meadows and along ditches. Beauregard (9672) and Webster (10303) Parishes.

Dichromena colorata (L.) Hitchc. Low moist open soil. Calcasieu Parish (9569).

Dichromena latifolia Baldw. Growing in water of wet soil along ditches and in depressions of savannahs and prairies. Calcasieu (9592) and Tangipahoa (9319) Parishes.

Fimbristylis autumnalis (L.) R. & S. var. *mucronulata* (Michx.) Fern. Moist or wet soil along rivers, in meadows and on seepage slopes. Bossier (10076), Rapides (9913) and Webster (10294) Parishes.

Fimbristylis castanea (Michx.) Vahl. Edge of saltwater canal. Iberia Parish (9534, 9540).

?*Fimbristylis Harperi* Britton. Low soil in prairie. Calcasieu Parish (9575).

Fimbristylis Vahlii (Lam.) Link. Sandy soil in flood area of the Red River. Bossier Parish (10072).

Bulbostylis capillaris (L.) C. B. Clarke. On sandy scrub oak hill. Natchitoches Parish (9970).

Scirpus robustus Pursh. In salt marshes. Iberia Parish (9560).

Scirpus validus Vahl. Edge of saltwater canal. Iberia Parish (9539).

Fuirena breviseta Coville. Wet or boggy soil in depressions of savannahs and prairies and on the edge of marshes. Beauregard (9677, 9679), Cameron (9595) and Tangipahoa (9318) Parishes.

Fuirena squarrosa Michx. Boggy soil in pocosins and on the edge of low swampy woods. Beauregard (9675), Calcasieu (9657), Natchitoches (9780) and Winn (10043) Parishes.

Rhynchospora corniculata (Lam.) Gray. In water or mud of ditches and swampy soil in prairie. Tangipahoa Parish (9317).

Rhynchospora corniculata (Lam.) Gray. In water or mud of ditches and swampy woods. Bossier (10132), East Baton Rouge (10392), Lafayette (9352) and Tangipahoa (9257) Parishes.

Rhynchospora cymosa Ell. var. *globularis* Chapm. Low moist soil at base of wooded slope. Rapides Parish (9914).

Rhynchospora glomerata (L.) Vahl. In wet soil along open or wooded streams and ditches. Natchitoches (9988) and Rapides (9911) Parishes.

Rhynchospora Grayii Kunth. Open dry sandy soil. Natchitoches Parish (9958).

Rhynchospora inexpansa (Michx.) Vahl. Moist or wet soil in open places and along ditches. Natchitoches (9989) and Tangipahoa (9290) Parishes.

Rhynchospora microcephala Britton. In a tupelo bog. Washington Parish.

Rhynchospora plumosa Ell. Low wet sandy soil. Natchitoches Parish (9955).

Cladium jamaicense Crantz. In salt marsh. Iberia Parish (9516).

Scleria hirtella Sw. In moist savannah land. Tangipahoa Parish (10537).

**Scleria flaccida* Steud. In tupelo bog. Washington Parish (9200).

Carex cherokeensis Schwein. Moist upland woods. Iberia Parish (9517).

Carex convoluta Mack. Moist wooded ravine slope. West Feliciana Parish (10450).

Carex Crus-corvi Shuttlw. In mud on edge of swamp. St. John the Baptist Parish (9330).

Carex Frankii Kunth. Wet soil on edge of swamps. Lafayette (9370) and St. John the Baptist (9327) Parishes.

Carex glaucescens Ell. Low moist sandy soil on edge of stream. Natchitoches Parish (9778).

Carex intumescens Rudge. On margin of pool in low woods. Bossier Parish (10114).

Carex Joorii Bailey. In low moist woods. Bossier Parish (10115).

Carex leptalea Wahlenb. var. *Harperi* (Fern.) Stone. In tupelo bog. Washington Parish (9193).

Carex Longii Mack. Edge of ditch. Lafayette Parish (9483).

Carex louisianica Bailey. Low moist woods. Lafayette Parish (9431).

**Carex lupuliformis* Sartwell. In mud of low woods. East Baton Rouge Parish (10404).

Carex lupulina Muhl. Low wet soil. Lafayette Parish (9373).

Carex lurida Wahlenb. In mud and wet soil of swampy woods along streams or on seepage slopes. Claiborne (10345), Rapides (9699), Washington (9229) and Winn (10032) Parishes.

Carex tribuloides Wahlenb. In mud of swampy woods. Tangipahoa Parish (9284).

Carex Willdenowii Schkuhr. In low moist woods. Iberia Parish (9557).

Arecaceae

Sabal minor (Jacq.) Pers. Moist soil in wooded ravines, gulches and on edge of woods. Iberia (9565), Natchitoches (9966) and West Feliciana (10459) Parishes.

Araceae

Arisaema Dracontium (L.) Schott. Moist or wet soil in densely wooded ravines or low woods. Iberia (9505) and Lafayette (9360) Parishes.

Arisaema atrorubens (Ait.) Blume. Moist wooded hill, rich soil. Rapides Parish (9720).

Eriocaulaceae

Eriocaulon decangulare L. Boggy or low soil in savannahs and prairies. Natchitoches (9788) and Tangipahoa (9316) Parishes.

**Eriocaulon lineare* Small (approaching *E. Benthami* Kunth, a Mexican species). In seepage on high open hill. Natchitoches Parish (9960).

**Lachnocaulon minus* (Chapm.) Small. Sandy wet soil along open ditch. Natchitoches Parish (9785).

Xyridaceae

Xyris ambigua Beyr. In seepage on open hillside. Natchitoches Parish (9963).

?*Xyris caroliniana* Walt. In tupelo swamp. Washington Parish (9201).

**Xyris Curtissii* Malme. In water of rocky stream on hillside. Natchitoches Parish (9980).

**Xyris difformis* Chapm. Edge of water along canals and in seepage on edge of woods. Calcasieu (9570) and Webster (10285) Parishes.

Xyris flexuosa Muhl. Low soil in open prairies. Tangipahoa Parish (9320).
Xyris platylepis Chapm. Open seepage slope. Natchitoches Parish (9798).

Mayacaceae

Mayaca Aubleti Michx. In boggy soil under tupelo trees. Washington Parish (9181).

Commelinaceae

**Tradescantia hirsuticaulis* Small. In low moist pine woods along stream. Rapides Parish (9890).

**Tradescantia subaspera* Ker-Gawl. In wet soil of low moist woods. Iberia (9502) and St. Landry (9473) Parishes.

Commelina erecta L. var. *angustifolia* (Michx.) Fern. In sandy soil along beaches and in scrub oak regions. Cameron (9602) and Natchitoches (9972) Parishes.

Commelina virginica L. Low moist soil along wooded stream. Rapides Parish (9851).

Bromeliaceae

Tillandsia usneoides L. On magnolia and live oak trees. Livingston Parish (9168A).

Pontederiaceae

Pontederia cordata L. In water of canal along road. Tangipahoa Parish (10541).

Juncaceae

Juncus biflorus Ell. Open swampy soil. Tangipahoa Parish (9273).

Juncus coriaceus Mack. In mud or wet soil along ditches and in depressions. Natchitoches (9990) and Tangipahoa (9289, 9271) Parishes.

Juncus effusus L. var. *solutus* Fern. & Wieg. Edge of saltwater canal. Iberia Parish (9561).

**Juncus Longii* Fern. In low moist sandy soil. Natchitoches Parish (9954).

Juncus macer S. F. Gray. In mud or wet soil along ditches, streams and wooded roads. Livingston (9142), Rapides (9915) and St. Mary (9336) Parishes.

Juncus repens Michx. In wet soil of depressions in savannahs. Tangipahoa Parish (9285).

Juncus scirpoides Lam. Low moist sandy soil along stream. Natchitoches Parish (9779).

Juncus validus Coville. Open sandy soil. Tangipahoa Parish (9291).

Liliaceae

Stenanthium gramineum (Ker) Kunth. Dry soil on pine woods slope or in the open. De Soto (10202) and Natchitoches (9786) Parishes.

**Melanthium dispersum* Small. In tupelo bog. Washington Parish (9194).

Lilium Catesbaei Walt. var. *Longii* Fern. In sandy flat pinewoods near pocosin. Tangipahoa Parish (10509).

Aletris aurea Walt. In dry sandy soil of savannah. Tangipahoa Parish (9314).

Smilax Bona-nox L. Climbing on trees in low moist woods and on dry pine woods slope. Claiborne (10342) and St. Martin (9456) Parishes.

Smilax glauca Walt. Climbing on bushes along streams and on ravine slopes. Tangipahoa (9265) and West Feliciana (10469) Parishes.

Smilax laurifolia L. Trailing over shrubs and small trees in low swampy woods. Rapides (9888) and Tangipahoa (10516) Parishes.

Smilax rotundifolia L. Trailing over shrubs and small trees in swampy woods and wooded ravine slopes. De Soto (10165), Lafayette (9377) and West Feliciana (10454) Parishes.

Smilax Walteri Pursh. Climbing on bushes on edge of swamp. Tangipahoa Parish (9304).

Dioscoreaceae

Dioscorea villosa L. forma *glabrifolia* (Bartlett) Fern. Trailing over weeds on edge of low swampy woods. Tangipahoa Parish (10521).

Amaryllidaceae

Crinum americanum L. In mud of swampy woods. Calcasieu Parish (9659).

Agave virginica L. Dry soil of pine-scrub oak sandhills, on sandy knolls in prairies and open moist fields. Beauregard (9678), Calcasieu (9626) and Rapides (9923) Parishes.

Hypoxis hirsuta (L.) Coville. Low moist open soil. Calcasieu Parish (9649).

Iridaceae

Eustylis purpurea (Herb.) Engelm. & Gray. Moist wooded slopes of ravines and along streams and in moist soil of prairies. Calcasieu (9589), Natchitoches (9763) and Rapides (9898) Parishes.

**Sisyrinchium Brownei* Small. Moist open soil, 1 mile east of Lake Charles. Calcasieu Parish (9647).

Orchidaceae

**Cypripedium Calceolus* L. var. *pubescens* (Willd.) Correll. Taken from garden of Mrs. P. Weiss in Natchitoches (collected by her near Robeline). Natchitoches Parish (9817).

Habenaria ciliaris (L.) R. Br. In bogs, seepage slopes, depressions in prairies and savannahs, wet places in open-woods or rarely dry rocky soil. Bienville (10050), Bossier (10248), Rapides (9700, 9840), Tangipahoa (10508), Washington (9196, 10298) and Winn (10040) Parishes.

Habenaria cristata (Michx.) R. Br. Habitat similar to *H. ciliaris*. Beauregard (9664), Bossier (10249), Claiborne (10330), Natchitoches (9797), Rapides (9698, 9841), Tangipahoa (10514), Vernon (9687) and Winn (10041) Parishes.

**Habenaria integra* (Nutt.) Spreng. Low depressions in prairie. Beauregard Parish (9663).

**Habenaria flava* (L.) R. Br. In mud of flooded woods. Tangipahoa Parish (9281, 10513, 10544).

Habenaria clavellata (Michx.) Spreng. In water of streams in dense woods, bogs, seepage slopes and thickets. Bossier (10250), Claiborne (10325), Ouachita (10367), Rapides (9697, 9852), Washington (9195, 9220), Webster (10300) and Winn (10038) Parishes.

**Habenaria nivea* (Nutt.) Spreng. In depressions of prairies and savannahs. Beauregard Parish (9666).

Pogonia ophioglossoides (L.) Ker-Gawl. Open seepage slope on high hill. Natchitoches Parish (9946).

**Isotria verticillata* (Willd.) Raf. Moist rich soil in low woods. Grant Parish (9734).

Calopogon pulchellus (Salisb.) R. Br. In depressions in prairies and savannahs. Beauregard Parish (9665).

**Ponthieva racemosa* (Walt.) Mohr. Rich wooded slope in deep ravine at outcrop of marl. West Feliciana Parish (10475).

Spiranthes Beckii Lindl. Dry soil of pine-hardwood slopes. Bossier (10120) and Natchitoches (9743) Parishes.

**Spiranthes ovalis* Lindl. Rich soil in low open hardwood forest. Caldwell Parish (10374).

**Erythrodes querceticola* (Lindl.) Ames. Moist wooded slope, growing with *Oplismenus setarius*. West Feliciana Parish (10474).

Malaxis unifolia Michx. In rich soil and humus of pine-hardwood forest. Caddo (10140), Claiborne (10339), De Soto (10195), Grant (9736), Rapides (9695), Webster (10290) and Winn (10025) Parishes.

Tipularia discolor (Pursh) Nutt. In rich soil and humus of pine-hardwood forests, commonly under beech trees. Bossier (10119), Claiborne (10324), De Soto (10177, 10210), Evangeline (10384), Grant (9735, 10382), Natchitoches (9819),

Rapides (9696), Webster (10283), West Feliciana (10446, 10476) and Winn (10000, 10037) Parishes.

**Hexalectris spicata* (Walt.) Barnhart. In rich humus of dense woods, in vicinity of limestone or marl. Natchitoches (9818) and Winn (10036) Parishes.

Epidendrum conopseum R. Br. On various species of trees, particularly magnolias. Calcasieu (9660, westernmost station known) and Livingston (9158, 9168, 9169) Parishes.

Myricaceae

Myrica Pensylvanica Lois. In tupelo bog. Washington Parish (9189).

Myrica cerifera L. In dry soil of pasture. Iberia Parish (9498).

Juglandaceae

Carya aquatica (Michx. f.) Nutt. Low moist woods along streams. St. Martin Parish (9393, 9452).

Carya cordiformis (Wang.) K. Koch. Edge of woods at summit of ravine. West Feliciana Parish (10436).

**Carya laciniosa* (Michx. f.) Loud. Open-wooded ravine. Bossier Parish (10128).

Carya leiodermis Sarg. Dry soil in pine-scrub oak sandhills and in cut-over woodlands. Rapides (9717) and Winn (10007) Parishes.

Carya Pecan (Marsh.) Engl. & Graebn. Along a small stream bank. St. Martin Parish (9392).

Carya tomentosa Nutt. Open dry slope above a swampy forest. Natchitoches Parish (9822).

Carya tomentosa Nutt. var. *subcoriacea* (Sarg.) Palmer & Steyermark. Dry soil on open slopes or edge of woods. Bossier (10225) and Natchitoches (9823) Parishes.

Betulaceae

Carpinus caroliniana Walt. In dense woods along stream. Livingston Parish (9138).

Alnus rugosa (Du Roi) Spreng. In boggy or moist soil along stream banks. Natchitoches Parish (9765, 9774).

Fagaceae

Fagus grandifolia Ehrh. In low woods along stream bank. Livingston Parish (9165).

Castanea floridana (Sarg.) Ashe. Wooded slope on edge of cypress swamp. Rapides Parish (9996).

Castanea pumila (L.) Mill. Open dry soil on campus of Louisiana College, Pineville. Rapides Parish (9694).

Castanea pumila (L.) Mill. var. *Ashei* Sudw. Wooded slope on edge of cypress swamp and on edge of upland woods. Rapides (9995) and Webster (10315, 10317) Parishes.

Quercus cinerea Michx. Open dry sandhill region. Natchitoches Parish (9752).

**Quercus imbricaria* Michx. Open sandy soil in post oak-black jack oak and pine association. Rapides Parish (9691).

Quercus marilandica Muench. In pine-scrub oak sandhill area. Bossier Parish (10260).

Quercus nigra L. Growing along stream bank. St. Martin Parish (9397).

**Quercus obtusa* Ashe. Low moist woods and open moist soil. Lafayette (9429) and Tangipahoa (10539) Parishes.

Quercus montana Michx. Open pasture slope. St. Landry Parish (9478).

Quercus stellata Wang. Dry soil of pine-scrub oak sandhills. Bossier Parish (10264).

Urticaceae

Ulmus alata Michx. Moist wooded slope. St. Landry Parish (9475).

Ulmus crassifolia Nutt. In low flooded woodlands. Natchitoches Parish (9821).

Ulmus fulva Michx. Low moist woods. Iberia Parish (9501).

Celtis laevigata Willd. Swampy woods along the Vermilion River. Lafayette Parish (9348).

**Celtis pumila* Pursh. Sandy soil along bank of the Sabine River. De Soto Parish (10179).

**Celtis pumila* Pursh var. *georgiana* (Small) Sarg. On bank of wooded stream. Claiborne Parish (10340).

Maclura pomifera (Raf.) Schneider. Dry soil of hillside pasture. Iberia Parish (9553).

Laportea canadensis (L.) Gaud. Wet soil along wooded stream bank. St. Landry Parish (9472).

Boehmeria cylindrica (L.) Sw. Moist soil of low moist woods and seepage slopes. East Baton Rouge (10395) and Rapides (9843) Parishes.

**Boehmeria cylindrica* (L.) Sw. var. *Drummondiana* Wed. Edge of boggy soil. Claiborne Parish (10348).

Loranthaceae

Phoradendron flavescens (Pursh) Nutt. Parasitic on *Acer floridanum*. Natchitoches Parish (9746).

Aristolochiaceae

**Asarum arifolium* Michx. Moist wooded slope along stream in ravine. Washington Parish (9232).

Polygonaceae

Rumex Berlandieri Meisn. Moist open grassy soil and in saltwater marshes. Iberia (9532) and St. Mary (9341) Parishes.

Rumex verticillatus L. Swampy soil. Lafayette Parish (9368).

Polygonum Persicaria L. Wet soil along ditch in open meadow. Lafayette Parish (9419).

Tovara virginiana (L.) Adans. In moist soil of low pinewoods. Livingston Parish (9170).

Polygonella americana (F. & M.) Small Growing on dry open sandy soil in Mrs. Ruth M. Dormon's garden (collected by her in sandhills of Bienville Parish). Caddo Parish (10144).

Brunnichia cirrhosa Gaertn. Climbing on trees in woods and swamps. Caddo (10142) and Tangipahoa (9296) Parishes.

Chenopodiaceae

Chenopodium ambrosioides L. Among rank weeds in open swampland. Tangipahoa Parish (9243).

Chenopodium Berlandieri Moq. Above high tide along Holly Beach. Cameron Parish (9610).

Atriplex arenaria Nutt. Above high tide along Holly Beach. Cameron Parish (9609).

Salicornia Bigelovii Torr. Above high tide along Holly Beach. Cameron Parish (9617).

Suaeda linearis (Ell.) Moq. Above high tide along Holly Beach. Cameron Parish (9611).

Amaranthaceae

**Acnida cannabina* L. Along saltwater canal. Iberia Parish (9535).

Alternanthera philoxeroides (Mart.) Griseb. Wet soil along ditch. Tangipahoa Parish (9251).

**Cladothrix lanuginosa* Nutt. Above high tide along Holly Beach. Cameron Parish (9608).

**Froelichia floridana* (Nutt.) Moq. In dry soil along railroad embankment. Bienville Parish (10047).

**Comphrena globosa* L. Open waste ground on edge of pastureland. St. Landry Parish (9468).

Phytolaccaceae

Phytolacca americana L. On edge of low swampy woods. Natchitoches Parish (9744).

Nyctaginaceae

**Mirabilis Jalapa* L. Open waste ground on edge of pasture. St. Landry Parish (9471).

Boerhaavia erecta L. In gravelly dry soil along railroad embankment. Tangipahoa Parish (9234).

Illecebraceae

**Paronychia fastigiata* (Raf.) Fern. Dry soil in thinly wooded area. Caddo Parish (10096).

Aizoaceae

Mollugo verticillata L. In burnt-over soil of pine-scrub oak sandhills. Rapides Parish (9920).

Caryophyllaceae

**Silene subciliata* Robinson. Growing in Mrs. Ruth M. Dormon's garden (obtained by her from Sabine Parish in wild condition). Caddo Parish (10265).

Portulacaceae

Talinum paniculatum (Jacq.) Gaertn. Open waste ground on edge of pasture. St. Landry Parish (9470).

Ranunculaceae

**Clematis Catesbyana* Pursh. Trailing on small trees along logging road. West Feliciana Parish (10467).

Clematis crispa L. Trailing on bushes and shrubs along ditches, streams and on the edge of swamps. Calcasieu (9655), St. Mary (9340) and Tangipahoa (10542) Parishes.

**Actaea pachypoda* Ell. On a deep north-facing wooded ravine slope. West Feliciana Parish (10437).

Magnoliaceae

Illicium floridanum Ellis. Along stream bank in wooded ravine. Washington Parish (9230).

Magnolia grandiflora L. On wooded hill, edge of swamp. Rapides Parish (9718).

Magnolia macrophylla Michx. On wooded slope along stream. Washington Parish (9215).

Magnolia virginiana L. var. *australis* Sarg. In swampy woods, along streams and in gulches. Bossier (10243), De Soto (10174), Natchitoches (9751) and Rapides (9850) Parishes.

Anonaceae

**Asimina parviflora* (Michx.) Dunal. Moist wooded slope. De Soto Parish (10218).

Asimina triloba Dunal. Moist wooded slope along ravine. Iberia Parish (9523).

Menispermaceae

Cocculus carolinus (L.) DC. Climbing on small trees in woods and on edge of woods. Lafayette (9358) and West Feliciana (10458) Parishes.

Berberidaceae

Podophyllum peltatum L. Flood area of woods along stream. De Soto Parish (10197).

Lauraceae

**Cinnamomum camphora* (L.) Nees & Eberm. On edge of dense swampy woods. Iberia Parish (9529).

**Lindera Benzoin* (L.) Bl. var. *pubescens* (Palmer & Steyermark) Rehd. Along an

open swamp road and wooded ravines. East Baton Rouge (10396) and West Feliciana (10435, 10457) Parishes.

Cruciferae

Lepidium virginicum L. Edge of swamp. Tangipahoa Parish (9236).

Coronopus didymus (L.) Smith. Low moist open soil. Calcasieu Parish (9648).

Rorippa islandica (Oeder) Borbás. Moist open soil and in flood areas of rivers. Bossier (10068) and Lafayette (9374) Parishes.

Rorippa sessiliflora (Nutt.) Hitchc. Sandy soil, flood area of the Red River. Bossier Parish (10068A).

Capparidaceae

Cleome spinosa (L.) Jacq. In wet soil of canal. Iberia Parish (9385).

Sarraceniaceae

Sarracenia flava L. Boggy depressions in savannahs. Natchitoches (9792) and Tangipahoa (10540) Parishes.

Droseraceae

Drosera capillaris Poir. In seepage on high open hillside. Natchitoches Parish (9959).

Crassulaceae

Penthorum sedoides L. Low moist woods. Livingston Parish (9133).

Saxifragaceae

Decumaria barbara L. Climbing on trees in tupelo swamp and wooded ravines. Washington (9197) and West Feliciana (10464) Parishes.

Hydrangea arborescens L. Partly cut-over moist ravine slope. West Feliciana Parish (10419).

**Hydrangea quercifolia* Bartr. On bank of wooded ravine. West Feliciana Parish (10418).

Itea virginica L. Along bank of bayou. Webster Parish (10306).

Hamamelidaceae

Hamamelis virginiana L. Moist wooded slopes along streams. Claiborne (10341) and Washington (9217) Parishes.

Liquidambar Styraciflua L. Upland moist woods. Iberia Parish (9504).

Platanaceae

Platanus occidentalis L. Along a ditch in an open field. Calcasieu Parish (9635).

Rosaceae

**Gillenia stipulata* (Muhl.) Trel. In dry soil of pine-hardwood forest. De Soto Parish (10203).

Malus angustifolia (Ait.) Michx. Edge of low swampy woods. Tangipahoa Parish (10538).

Crataegus brachyacantha Sarg. & Engelm. Low moist woods. Caddo Parish (10153).

**Crataegus Crus-galli* L. Dry soil of pine-scrub oak sandhills. Bossier Parish (10263).

**Crataegus drymophila* Sarg. Edge of low moist woods. Caldwell Parish (10378).

Crataegus Marshallii Eggleston. Edge of pine woods slope. Natchitoches Parish (9824).

Crataegus viridis L. Low moist open woods. St. Martin Parish (9453).

**Duchesnea indica* (Andr.) Focke. In dry shaded soil under railroad trestle, 1 mile southeast of Broussard. Lafayette Parish (9363).

Geum canadense Jacq. Moist soil of wooded ravine. Iberia Parish (9507).

**Agrimonia gryposepala* Wallr. On slopes of wooded ravine. Caddo Parish (10137).

Agrimonia microcarpa Wallr. Moist soil on wooded slope. Rapides Parish (9882).

**Agrimonia rostellata* Wallr. Moist or dry soil in woods or on the edge of woods. Iberia (9522) and West Feliciana (10455) Parishes.

Rosa bracteata Wendl. On edge of ditch along road. East Baton Rouge Parish (10495).

Prunus caroliniana Ait. On bank of wooded ravine. Iberia Parish (9520).

**Prunus mitis* Beadle. In upland pine-hardwood forest. Natchitoches Parish (9828).

Prunus umbellata Ell. Dry soil along old wood road. Winn Parish (10006).

Leguminosae

Acacia Farnesiana (L.) Willd. Low bank along road. Calcasieu Parish (9623).

Desmanthus illinoensis (Michx.) MacM. Above high tide along Holly Beach. Cameron Parish (9601).

Mimosa strigillosa T. & G. Dry or moist soil along roadshoulder or in ditches. Natchitoches (9813) and St. Martin (9450) Parishes.

**Neptunia lutea* (Leavenw.) Benth. In rather dry open sandy-clayey soil. Bossier Parish (10262).

Schrankia uncinata Willd. Low soil in prairie. Calcasieu Parish (9587).

Gleditsia triacanthos L. Dry or moist soil in low woods or on open slopes. Caddo (10320) and St. Martin (9451) Parishes.

Cassia fasciculata Michx. var. *littoralis* (Pollard) Macbr. In dry or moist soil on knolls in prairies or thinly wooded slopes. Calcasieu (9637) and Rapides (9690) Parishes.

**Cassia marilandica* L. Moist soil of wooded pastureland. Natchitoches Parish (9987).

Cassia Tora L. Moist rich soil near old deserted barn. De Soto Parish (10186).

Cercis canadensis L. Moist wooded slopes. Iberia (9542) and St. Landry (9474) Parishes.

Crotalaria sagittalis L. In dry soil on roadshoulders and in pine-scrub oak sandhills. Calcasieu (9656) and Rapides (9916, 9940) Parishes.

Medicago lupulina L. Sandy soil in flood area of the Red River. Bossier Parish (10061).

Medicago sativa L. On dry roadshoulder. Caddo Parish (10269).

**Petalostemum emarginatum* T. & G. Above high tide along Holly Beach. Cameron Parish (9613).

Tephrosia hispidula (Michx.) Pers. On dry open wooded hillside. Rapides Parish (9933).

Tephrosia virginiana (L.) Pers. Sandy soil in pine-scrub oak sandhills. Rapides Parish (9713).

Sesbania exaltata (Raf.) Rydb. Along edge of small canal. Tangipahoa Parish (10543).

Glottidium vesicarium (Jacq.) Harper var. *atrorubrum* (Nash) Small. In moist or wet soil of seepage slopes or open fields. Caddo (10136) and De Soto (10167) Parishes.

Daubentonia Drummondii Rydb. In open marsh. Cameron Parish (9598).

Robinia pseudoacacia L. Rather dry soil on slopes and in open fields. Caddo (10266) and East Feliciana (10493) Parishes.

**Aeschynomene sensitiva* Swartz. In ditch along road, about 3 miles east of Robert. Tangipahoa Parish (10527).

Desmodium acuminatum (Michx.) DC. Moist soil of partly cut-over wooded ravine slope. West Feliciana Parish (10423).

Desmodium nudiflorum (L.) DC. In moist soil of pine-hardwood forests. Rapides (9844) and Washington (9219) Parishes.

Desmodium pauciflorum (Nutt.) DC. In moist or wet soil of swampy woods or in ravines. West Feliciana (10461) and Winn (10001) Parishes.

Desmodium sessilifolium (Torr.) T. & G. Dry soil of open slope. Claiborne Parish (10337).

Lespedeza striata (Thunb.) H. & A. In dry soil of open field. Webster Parish (10286).

Lespedeza virginica (L.) Britton. Dry soil of thinly wooded slope. Caddo Parish (10268).

Stylosanthes biflora (L.) B. S. P. Dry soil along roadshoulder. Natchitoches Parish (9812).

**Apios tuberosa* Moench. var. *turrigera* Fern. Trailing on bushes in low places. Claiborne Parish (10321).

Phaseolus polystachyus (L.) B. S. P. Climbing on small trees in densely wooded ravine. West Feliciana Parish (10416).

Centrosema virginianum (L.) Benth. Creeping over weeds on moist open slopes. Iberia (9497) and Rapides (9924) Parishes.

Galactia volubilis (L.) Britton. Trailing over weeds on open hillsides and on edge of swampy woods. Rapides (9847) and Tangipahoa (10519) Parishes.

Rhynchosia erecta (Walt.) DC. In dry soil of thinly wooded slope. Winn Parish (10031).

Erythrina herbacea L. Dry or moist soil of wooded ravine slopes. Rapides Parish (9839, 9991).

Linaceae

Linum floridanum (Planch.) Trel. Moist open sandy soil. Beauregard Parish (9682).

Oxalidaceae

**Oxalis florida* Salisb. In burnt-over pine-scrub oak sandhills. Rapides Parish (9938).

Oxalis stricta L. Moist soil in open. Calcasieu Parish (9650).

Oxalis violacea L. In dry soil of pine-hardwood forest. Bossier Parish (10130).

Rutaceae

Zanthoxylum Clava-Herculis L. Open land along the Bayou Teche. St. Martin Parish (9403).

Ptelea trifoliata L. var. *mollis* T. & G. Along a wooded stream. Vernon Parish (9685).

Poncirus trifoliata (L.) Raf. In upland moist woods. Iberia Parish (9494).

Meliaceae

Melia Azedarach L. in dry soil of open field. Caddo Parish (10089).

Polygalaceae

**Polygala cruciata* L. var. *cuspidata* (H. & A.) Wood. In moist soil on edge of swamp. Tangipahoa Parish (9313).

Polygala Harperi Small. In moist soil of fields and on knolls in prairies, Calcasieu Parish (9583, 9640).

**Polygala incarnata* L. Open boggy soil. Natchitoches Parish (9789).

Polygala ramosa Ell. Moist or wet soil in bogs or swamps, commonly in depressions in savannahs. Beauregard (9668) and Tangipahoa (9312) Parishes.

Euphorbiaceae

Jatropha texana Muell. Arg. Open sandy hilltop. Natchitoches Parish (9986).

Croton capitatus Michx. Open dry hillside. Natchitoches Parish (9808).

Croton glandulosus L. var. *angustifolius* Muell. Arg. Above high tide along Holly Beach. Cameron Parish (9615).

Croton glandulosus L. var. *septentrionalis* Muell. Arg. Moist soil in burnt-over woods. Rapides Parish (9863).

Croton monanthogynus Michx. In dry soil of thinly wooded area. Caddo Parish (10094).

Crotonopsis elliptica Willd. Dry soil of pine-scrub oak sandhills. Rapides Parish (9881).

Acalypha gracilens A. Gray. Moist sandy soil in dry stream. Rapides Parish (9837).

**Acalypha rhomboidea* Raf. In rank weeds of open marshland. Tangipahoa Parish (9244).

**Tragia urens* L. var. *linearis* Michx. On summit of dry sandy rocky scrub oak hill. Natchitoches Parish (9971).

Tragia urticifolia Michx. Dry soil in pine-scrub oak regions. Natchitoches (9777) and Rapides (9857) Parishes.

Sebastiana ligustrina (Michx.) Muell. In swampy woods. Livingston Parish (9140).

Stillingia sylvatica L. var. *salicifolia* Torr. On dry pine woods slope. Rapides Parish (9936).

Sapium sebiferum (L.) Roxb. Along small ditch in open field. Calcasieu Parish (9630).

Phyllanthus carolinensis Walt. Moist grassy place in open place in woods. East Baton Rouge Parish (10394).

Euphorbia cordifolia Ell. In dry soil on exposed slope of sandhills. Natchitoches Parish (9758).

Euphorbia corollata L. In dry soil of pine-scrub oak sandhills, along roadshoulders or in poor soil on edges of woods. Caddo (10083), Lafayette (9364), Rapides (9861), Tangipahoa (9278, 9279) and Washington (9218) Parishes.

**Euphorbia corollata* L. var. *angustifolia* Ell. Dry soil in thin pine woods. Tangipahoa Parish (9279A).

**Euphorbia corollata* L. var. *apocynifolia* (Small) Millsp. Dry soil of thinly wooded slope. Rapides Parish (9701).

**Euphorbia corollata* L. var. *Joorii* Norton. Open moist field. Calcasieu Parish (9641).

Euphorbia heterophylla L. Marsh land. Tangipahoa Parish (9238).

Euphorbia maculata L. Dry soil along railroad embankment. Tangipahoa Parish (9247).

Euphorbia supina Raf. Dry gravelly soil along railroad track. Tangipahoa Parish (9249).

Buxaceae

**Pachysandra procumbens* Michx. Wooded steep ravine slope, about 1 mile west of the Plettenberg Post Office. West Feliciana Parish (10451).

Anacardiaceae

Rhus copallina L. Dry sandy soil on edge of woods. Washington Parish (9221).

Rhus glabra L. Dry rocky brushy soil on edge of woods or open slopes. Caddo (10085) and Natchitoches (9827) Parishes.

Cyrillaceae

Cyrilla racemiflora L. Edge of low dense swampy woods. Tangipahoa Parish (9302, 10522).

Aquifoliaceae

Ilex ambigua (Michx.) Chapm. In deep wooded ravines and along bayous. Webster (10319) and West Feliciana (10421) Parishes.

Ilex coriacea (Pursh) Chapm. In tupelo swamp. Washington Parish (9199).

Ilex decidua Walt. In moist soil in wooded ravines, along streams and on edge of woods. Natchitoches (9825) and St. Martin (9394, 9455) Parishes.

Ilex glabra (L.) Gray. Dry soil of thinly wooded pine slope. Tangipahoa Parish (10506).

Ilex opaca Ait. In moist woods along streams or in wooded ravines. Iberia (9493) and Washington (9225) Parishes.

Ilex verticillata (L.) Gray. On edge of swampy woods. Tangipahoa Parish (9280).

Ilex vomitoria Ait. In thicket along stream. Tangipahoa Parish (9267).

Celastraceae

Evonymus americanus L. In low swampy woods. Webster Parish (10288).

Aceraceae

Acer floridanum (Chapm.) Pax. Low moist woods along the Red River. Natchitoches Parish (9745).

Sapindaceae

Aesculus discolor Pursh var. *mollis* (Raf.) Sarg. On slope of thinly wooded ravine. Caddo Parish (10139).

Balsaminaceae

Impatiens biflora Walt. In wet soil on edge of low swampy woods. Caddo Parish (10145).

Rhamnaceae

Berchemia scandens (Hill) Trel. Climbing on bushes in thicket along streams. Tangipahoa Parish (9263).

Rhamnus caroliniana Walt. var. *mollis* Fern. On edge of dense swamp. Livingston Parish (9130).

Ceanothus americanus L. var. *Pitcheri* T. & G. Dry open pine woods, growing with *Andropogon* spp. Lincoln Parish (10351).

Vitaceae

Psedera quinquefolia (L.) Greene. Climbing in trees on edge of swamp. Bossier Parish (10258).

Cissus Ampelopsis Pers. Climbing over trees in swamp. Lafayette Parish (9379).

Cissus arborea (L.) Des Moulins. Climbing on shrubs. East Baton Rouge Parish (9120).

Cissus incisa (Nutt.) Des Moulins. Climbing on and hanging from a rock ledge on wooded slope. Winn Parish (10005).

Vitis cinerea Engelm. Climbing on bushes and small trees. Caddo (10091), De Soto (10182) and Natchitoches (9747) Parishes.

Vitis palmata Vahl. In low moist woods along the Sabine River. De Soto Parish (10190).

Vitis rotundifolia Michx. Climbing on small trees along wooded stream. St. Martin Parish (9395).

Tiliaceae

Tilia caroliniana Mill. In moist soil on wooded slopes and along wooded streams and river banks. De Soto (10191) and St. Landry (9477) Parishes.

**Tilia floridana* Small. Along open rim of wooded ravine. Caddo Parish (10134).

Malvaceae

**Sida Elliottii* T. & G. In open dry soil. East Baton Rouge Parish (10496).

Sida rhombifolia L. In mixed pine--hardwood forest. Livingston Parish (9164).

Callirhöe Papaver (Cass.) A. Gray. Moist open grassy soil in pine-scrub oak sandhill area. Rapides Parish (9835).

Hibiscus aculeatus Walt. On sandy pine woods slope. Tangipahoa Parish (10517).

Kosteletzkya virginica (L.) Presl. Along edge of saltwater canal. Cameron Parish (9622).

Buettneriaceae

**Firmiana simplex* (L.) Wight. Growing on vacant lot in Natchitoches. Natchitoches Parish (9749).

Tamaricaceae

Tamarix gallica L. On edge of and in water of ditches near Creole. Cameron Parish (9599).

Hypericaceae

Ascyrum hypericoides L. Dry soil of thinly wooded pine slope. Rapides Parish (9879).

Ascyrum stans Michx. Open sandy soil along road. Beauregard Parish (9681).

Hypericum Drummondii (Grev. & Hook.) T. & G. Dry or moist soil along open ditches or along road in cut-over woods. De Soto (10168) and Rapides (9896) Parishes.

Hypericum fasciculatum Lam. Moist soil along canal. Calcasieu Parish (9573).

Hypericum gentianoides (L.) B. S. P. Dry sandy soil on cut-over woods slope. Rapides Parish (9895).

**Hypericum lobocarpum* Gattinger. Moist soil on open slope along bayou. Webster Parish (10310).

Hypericum mutilum L. Low moist grassy soil and in mud along stream. Lafayette (9375) and Livingston (9161) Parishes.

**Hypericum nudiflorum* Michx. Boggy slope. Tangipahoa Parish (10511).

**Hypericum prolificum* L. Dry soil of pine-hardwood uplands. Natchitoches Parish (9829).

Hypericum punctatum Lam. In moist soil of low woodlands, ravines and upland woods. Caddo (10093), East Baton Rouge (10402) and West Feliciana (10431) Parishes.

Hypericum frondosum Michx. Dry soil of upland pine-hardwood forest. De Soto Parish (10178).

Cistaceae

Lechea tenuifolia Michx. Open dry soil on edge of pine woods. Natchitoches Parish (9826).

Lechea villosa Ell. Open dry eroded hillside. Rapides Parish (9932).

Passifloraceae

Passiflora incarnata L. Climbing on bushes in open soil. Lafayette Parish (9433).

Passiflora lutea L. var. *glabriflora* Fern. In burnt-over soil of pine-scrub oak sandhills. Rapides Parish (9939).

Lythraceae

Ammannia coccinea Rottb. Sandy open soil along the Red River. Bossier Parish (10065).

Lythrum lanceolatum Ell. In moist soil along roadside. Tangipahoa Parish (9270).

**Cuphea carthagenensis* (Jacq.) Macbr. Moist soil on edge of woods. East Baton Rouge Parish (10399).

Melastomaceae

Rhexia virginica L. In moist soil along small open streams. Rapides Parish (9925).

Onagraceae

Jussiaea leptocarpa Nutt. In wet soil of open ditch. Iberia Parish (9386).

**Jussiaea repens* L. var. *glabrescens* O. Ktze. In moist open ditch. St. Landry Parish (9460).

Ludvigia alternifolia L. In moist soil along open stream. Natchitoches Parish (9799).

Ludvigia glandulosa Walt. In mud of ditch along road. Lafayette Parish (9436).

Ludvigia pilosa Walt. Wet soil on edge of swamp. Tangipahoa Parish (9288).

Oenothera biennis L .On small knolls in prairies. Calcasieu Parish (9586).

Oenothera Drummondii Hook. Above high tide along Holly Beach. Cameron Parish (9603).

Oenothera laciniata Hill. Sandy open soil in flood area of the Red River. Bossier Parish (10073).

**Oenothera rhombipetala* Nutt. Sandy open soil along bank of the Sabine River. De Soto Parish (10181).

Oenothera speciosa Nutt. Dry open soil. Lafayette Parish (9382).

Gaura angustifolia Michx. On small sandy knolls in prairies. Calcasieu Parish (9636).

Gaura filiformis Small. Open dry soil. East Baton Rouge Parish (10497).

Haloragidaceae

Myriophyllum proserpinacoides Gill. Floating on water of canal. Tangipahoa Parish (9310).

Proserpinaca palustris L. In mud of swampy woods. Calcasieu Parish (9653).

Umbelliferae

Eryngium integrifolium Walt. In seepage of low meadow on edge of woods. Webster Parish (10312).

Eryngium prostratum Nutt. Growing in mud of small ditch in pine woods. Rapides Parish (9858).

Eryngium synchaetum (A. Gray) Rose. On open dry rocky hillside. Natchitoches Parish (9952).

**Eryngium Wrightii* A. Gray. Open low grassy soil. St. Martin Parish (9448).

Eryngium yuccifolium Michx. Moist open soil on edge of ditch. Calcasieu (9644) and Tangipahoa (9311) Parishes.

**Sanicula canadensis* L. var. *floridana* (Bickn.) Wolff. Moist sandy soil on pineland slope. Rapides Parish (9859).

Hydrocotyle verticillata Thunb. In mud of low swampy woods. Bossier (10254) and Livingston (9171) Parishes.

Trepocarpus Aethusae Nutt. Moist soil on edge of swamp. St. John the Baptist Parish (9328).

Ptilimnium capillaceum (Michx.) Raf. In mud along small stream. Livingston Parish (9157).

**Ptilimnium costatum* (Ell.) C. & R. Boggy open soil on edge of pocosin in vicinity of limestone quarry. Winn Parish (10042).

Ptilimnium Nuttallii (DC.) Britton. Low wet soil in open woods. Lafayette Parish (9427).

Cicuta Curtissii C. & R. In mud of stream on edge of cypress swamp. Rapides Parish (9992).

Oxypolis filiformis (Walt.) Britton. In savannah. Tangipahoa Parish (10534).

Oxypolis rigidior (L.) C. & R. In boggy soil of open seepage slope. Webster Parish (10308, 10309).

Cornaceae

Cornus asperifolia Michx. Dry or moist soil in open or on edge of dense woods. Iberia (9496) and Lafayette (9359) Parishes.

Cornus florida L. Upland moist hardwoods. Iberia Parish (9518).

Cornus stricta Lam. On edge of or in low moist woods. Lafayette (9430) and Ouachita (10366) Parishes.

Nyssa aquatica L. In water of open swamp. Iberia Parish (9510).

Nyssa sylvatica Marsh. In wooded ravine. Bossier Parish (10123).

Nyssa sylvatica Marsh. var. *biflora* (Walt.) Sarg. Wet soil in open. Tangipahoa Parish (10533).

Ericaceae

**Rhododendron arborescens* (Pursh) Torr. In tupelo bog. Washington Parish (9182).

**Rhododendron nudiflorum* (L.) Torr. On knoll in swampy woods. Webster Parish (10292).

**Kalmia latifolia* L. On deep ravine bank along stream in heavy shade. Washington Parish (9226).

**Leucothoë axillaris* (Lam.) D. Don. Along stream bank in woods. Washington Parish (9224).

**Leucothoë racemosa* (L.) Gray var. *elongata* (Small) Fern. Edge of low swampy woods. Ouachita Parish (10371).

**Lyonia ligustrina* (L.) DC. var. *capreaefolia* (Wats.) DC. Wet soil on edge of pocosin. Winn Parish (10039).

**Lyonia ligustrina* (L.) DC. var. *salicifolia* (Wats.) DC. In tupelo swamp, pocosins and low swampy woods. Washington (9198), Webster (10270) and Winn (10039) Parishes.

**Oxydendrum arboreum* (L.) DC. Moist wooded slope along stream. Rapides Parish (9855).

Vaccinium arboreum Marsh. In sandy soil on edge of woods. Washington Parish (9222).

Primulaceae

Samolus parviflorus Raf. In muddy soil of wooded streams. Livingston (9160) and St. Martin (9407) Parishes.

**Lysimachia lanceolata* Walt. On moist open-wooded slope. Rapides Parish (9880).

Lysimachia radicans Hook. In water of ditch in woods. Livingston Parish (9136).

Ebenaceae

Diospyros virginiana L. In sandy soil on edge of woods. Washington Parish (9223).

Styracaceae

Symplocos tinctoria (L.) L'Her. Moist soil on wooded ravine slopes and along small streams in rock outcrop. Natchitoches (9753) and West Feliciana (10470) Parishes.

Halesia diptera Ellis. On wooded ravine slopes and in moist wooded areas. Livingston (9143) and West Feliciana (10422) Parishes.

Styrax americana Lam. In thicket along stream and on edge of swamp. Tangipahoa (9264, 9294) Parish.

Styrax grandifolia Ait. On partly cut-over ravine slope. West Feliciana Parish (10420).

Styrax pulverulenta Michx. Low swampy woods. Caddo Parish (10147).

Oleaceae

Fraxinus americana L. Along wooded stream. Vernon Parish (9684).

Fraxinus caroliniana Mill. On edge of dense swamps or on edge of water of bayous. Calcasieu (9661), Tangipahoa (9303) and Webster (10314) Parishes.

Fraxinus pennsylvanica Marsh var. *lanceolata* (Borkh.) Sarg. In low swampy woods. Lafayette (9378) and St. Martin (9454) Parishes.

Ligustrum vulgare L. In thicket along stream. Tangipahoa Parish (9266).

Loganiaceae

Gelsemium Rankinii Small. Growing on bushes in ravine along stream. Washington Parish (9231).

Cynoctonum Mitreola (L.) Britton. In mud along wooded stream. Livingston Parish (9159).

Cynoctonum sessilifolium (Walt.) J. F. Gmel. Wet sandy soil along shallow ditch. Beauregard Parish (9673).

Polypremum procumbens L. Low moist open soil. Calcasieu Parish (9651).

Gentianaceae

Sabatia angularis (L.) Pursh. On seepage slope in pine woods. Rapides Parish (9842).

Sabatia campanulata (L.) Torr. var. *gracilis* (Michx.) Fern. In prairies. Tangipahoa Parish (9307).

Sabatia gentianoides Ell. Moist grassy savannahs and open moist rocky hillsides. Natchitoches Parish (9796, 9979).

Eustoma exaltatum (L.) Griseb. Sandy soil along edge of road, Holly Beach. Cameron Parish (9620).

Asclepiadaceae

Asclepiodora viridis (Walt.) A. Gray. Moist open grassy field. Calcasieu Parish (9628).

Asclepias obovata Ell. On small knolls in prairies or on open dry gentle slopes. Calcasieu (9578) and Natchitoches (9794) Parishes.

Asclepias perennis Walt. In mud and water of small swampy streams or in open streams. Lafayette (9422) and Livingston (9156) Parishes.

Asclepias rubra L. Moist soil of savannah. Natchitoches Parish (9795).

Asclepias tuberosa L. Dry sandy soil in pine-scrub oak sandhill areas and in pine-woods. Rapides Parish (9716, 9884, 9884A, 9944).

Asclepias variegata L. Rocky well-drained wooded slope. Bossier Parish (10127).

Asclepias verticillata L. Moist open hardwood forests and in cut-over woods. De Soto (10213) and Natchitoches (9793) Parishes.

Scutera palustris (Pursh) Vail. Trailing on weeds along edge of saltwater canal. Iberia Parish (9536).

Conolobus laevis Michx. Climbing on bushes on edge of swamp and along a small stream. Caddo (10095) and Lafayette (9381) Parishes.

Convolvulaceae

Ipomoea pandurata (L.) G. F. W. Mey. Climbing on fence along a ditch. Lafayette Parish (9484).

Ipomoea sagittata Poir. Growing on weeds along canal. Calcasieu Parish (9590).

**Jacquemontia tamnifolia* (L.) Griseb. In moist soil along wooded stream. Caddo Parish (10099).

Cuscutaceae

Cuscuta compacta Juss. Growing on various plants on dry cut-over woods slope. Bossier Parish (10246).

Cuscuta glandulosa (Engelm.) Small. Growing on small shrubs and herbs in pasture. Lafayette Parish (9418).

Hydrophyllaceae

Hydrolea affine A. Gray. In water or wet soil of small streams or in swampy woods. Lafayette (9355) and Webster (10307) Parishes.

Hydrolea ovata Nutt. In wet soil of open ditch. Lafayette Parish (9432).

Hydrolea quadrivalvis Walt. In mud of swampy ditch. Livingston Parish (9132).

Boraginaceae

Heliotropium curassavicum L. Sandy soil on edge of marsh and flood areas of rivers and streams. Bossier (10060) and Cameron (9597) Parishes.

Heliotropium indicum L. In wet soil or mud on edge of swamps and along ditches. Lafayette (9372, 9417) and Tangipahoa (9297) Parishes.

**Heliotropium procumbens* Mill. In weedy soil along stream and on flood area of the Red River. Bossier (10059) and Caddo (10098) Parishes.

Lithospermum tuberosum Rugel. In dry soil of upland pasture woods. Iberia Parish (9521).

Verbenaceae

Verbena bonariensis L. Rather dry soil in old fields. Tangipahoa Parish (9259).

Verbena canadensis (L.) Britton. Open dry pasture soil. East Baton Rouge Parish (10393).

Verbena Halei Small. Open dry gravelly soil along railroad embankment. Tangipahoa Parish (9254).

Verbena rigida (L.) Spreng. Dry soil in open fields and along ditches. East Baton Rouge (9118, 10449) and St. Mary (9346) Parishes.

Verbena scabra Vahl. In marshy land. Tangipahoa Parish (9239).

Verbena urticaefolia L. In dry or moist soil along streams and old wooded roads. Bossier (10057), Livingston (9129) and St. Martin (9406) Parishes.

Verbena xutha Lehm. Open dry soil along road. St. Martin Parish (9447).

Lippia nodiflora Michx. Moist open grassy soil or in sandy soil of flood areas of rivers. Bossier (10078) and St. Mary (9338) Parishes.

Callicarpa americana L. Open dry sandy soil on edge of woods. Livingston Parish (9167).

Labiatae

Teucrium canadense L. Wet soil in stream bed. St. Martin Parish (9402).

Teucrium occidentale Gray. Open place in low wet woods along river. Lafayette Parish (9350).

Scutellaria ovata Hill subsp. *versicolor* (Nutt.) Epl. Open moist bank along shore of the Red River. Natchitoches Parish (9740).

Dracocephalum sp. On well-drained open-wooded pine slope. De Soto Parish (10176).

Leonurus sibiricus L. Moist open grassy soils. Lafayette (9347) and St. Martin (9400) Parishes.

Leonotis nepetaefolia R. Br. Low moist open soil along the Bayou Teche. St. Martin Parish (9399).

Stachys tenuifolia Willd. Low moist open grassy soil. Lafayette (9416), St. Charles (9333) and St. Martin (9401) Parishes.

Salvia azurea Lam. subsp. *media* Epl. In dry soil of cut-over woods or on the edge of woods. Caddo (10152) and Webster (10281) Parishes.

Salvia lyrata L. Moist open woods slope. Rapides Parish (9883).

Monarda fistulosa L. Open moist wooded slope. Rapides Parish (9854).

Monarda Lindheimeri Gray. Edge of ditch. Calcasieu Parish (9572).

Monarda punctata L. Moist or dry soil in open along ditches and on edge of woods. Bossier (10245), Cameron (9596) and Webster (10316) Parishes.

?*Pycnanthemum albescens* T. & G. Dry or sandy soil in open. Vernon (9683) and Washington (9233) Parishes.

Pycnanthemum flexuosum (Walt.) B. S. P. In dry soil of cut-over woods slope or pinewoods. Calcasieu (9643), Tangipahoa (9277) and Webster (10302) Parishes.

Lycopus europaeus L. Low moist grassy meadow. Lafayette Parish (9420).

Hyptis radiata Willd. In wet or boggy soil in open or on edge of woods. Tangipahoa Parish (9252, 10520).

Perilla frutescens (L.) Britton. Low wet woods or dry cut-over woods slope. Bossier (10244) and St. Landry (9479) Parishes.

Solanaceae

Solanum carolinense L. Dry gravelly soil along railroad track. Tangipahoa Parish (9250).

**Solanum elaeagnifolium* Cav. In dry soil of open upland pasture. Iberia Parish (9551).

Physalis angulata L. In rank weeds of open swamp and in waste ground. Calcasieu (9567) and Tangipahoa (9240) Parishes.

Physalis barbadensis Jacq. var. *obscura* (Michx.) Rydb. Open waste ground. Calcasieu Parish (9566).

Physalis mollis Nutt. Open sandy waste soil along the Red River. Bossier Parish (10058).

Datura Stramonium L. Waste land on slope. Caddo Parish (10143).

Nicotiana Tabacum L. On edge of swamp in low open pasture land. St. Landry Parish (9466).

Scrophulariaceae

Verbascum Thapsus L. Open waste ground. Rapides Parish (9708).

**Scrophularia marilandica* L. On edge of logging road on ravine slope. West Feliciana Parish (10456).

Mimulus alatus Ait. Low wet soil or in water of ditches in low woods. Lafayette (9426) and Livingston (9137) Parishes.

**Conobea multifida* (Michx.) Benth. Sandy or eroded soil on banks of the Red River. Bossier (10079) and Natchitoches (9815) Parishes.

Bacopa Monnieria (L.) Wettst. On edge of water in open marsh. Iberia Parish (9511).

**Bacopa rotundifolia* (Michx.) Wettst. Floating in shallow water on edge of rice field. Calcasieu Parish (9631).

Mecardonia acuminata (Walt.) Small. In moist or wet soil of pocosins, meadows and on edge of swampy woods. De Soto (10196), Tangipahoa (10515) and Webster (10287) Parishes.

Lindernia anagallidea (Michx.) Pennell. Sandy open soil in flood area of the Red River. Bossier Parish (10063).

Gratiola pilosa Michx. In open wet grassy soil. Claiborne Parish (10349).

**Aureolaria flava* (L.) Farwell. Dry rocky wooded slope. Bossier Parish (10222).

Aureolaria grandiflora (Benth.) Pennell. Dry cut-over woods slope. De Soto Parish (10198).

Aureolaria grandiflora (Benth.) Pennell var. *serrata* (Torr.) Pennell. Dry soil of thinly wooded slopes. Rapides (9993) and Winn (10002) Parishes.

**Aureolaria pectinata* (Nutt.) Pennell. Dry soil of scrubby oak sandhill. Natchitoches Parish (9961).

Gerardia fasciculata Ell. In open dry field. East Baton Rouge Parish (10401).

Buchnera americana L. Open dry sandy soil. Natchitoches Parish (9761).

Buchnera floridana Gand. Moist open grassy soil. Calcasieu Parish (9571).

Pedicularis canadensis L. In dry soil on open pine slope. Natchitoches Parish (9739).

Lentibulariaceae

Utricularia biflora Lam. Floating on water of canal. Tangipahoa Parish (9309).

Pinguicula pumila Michx. In mud on edge of small pool on open slope. Natchitoches Parish (9814).

Orobanchaceae

Epifagus virginiana (L.) Bart. In rich soil under beech trees. Natchitoches (9820) and Webster (10284) Parishes.

Bignoniaceae

Tecoma radicans (L.) Juss. Creeping over bushes along open stream bank. Tangipahoa Parish (9235).

Catalpa speciosa Warder. In moist soil along open stream bank. De Soto Parish (10192).

Bignonia capreolata L. Growing on bushes in open pasture. Iberia Parish (9499).

Acanthaceae

Ruellia ciliosa Pursh. Low grassy soil. Calcasieu Parish (9652).

**Ruellia hybrida* Pursh. Moist open grassy woods. Iberia Parish (9525).

Justicia lanceolata (Chapm.) Small. In mud of ditch in swampy woods. Livingston Parish (9131).

Phrymaceae

Phryma leptostachya L. Moist banks of wooded ravine. Iberia Parish (9500).

Plantaginaceae

Plantago aristata Michx. Dry soil in open field. Tangipahoa Parish (9258).

Plantago Rugelii Decne. Low moist open woods. St. Martin Parish (9458).

Rubiaceae

Galium pilosum Ait. var. *puncticulosum* (Michx.) T. & G. On moist edge of open ditch. Natchitoches Parish (9784).

Galium triflorum Michx. var. *asprelliforme* Fern. Moist soil of upland woods and along streams. Iberia (9509) and West Feliciana (10465) Parishes.

Galium uniflorum Michx. Moist soil in wooded ravine. Bossier (10121) and West Feliciana (10471) Parishes.

Spermacoce glabra Michx. Wet sandy soil in rock crevice. De Soto Parish (10180).

Diodia teres Walt. In open dry soil. Caddo Parish (10101).

Mitchella repens L. In low moist woods along streams. De Soto (10214) and Rapides (9935) Parishes.

Cephalanthus occidentalis L. Wet soil along open ditch. Tangipahoa Parish (10546).

**Houstonia nigricans* (Lam.) Fern. Moist prairie soil. Calcasieu Parish (9582).

Caprifoliaceae

Lonicera sempervirens L. Trailing on shrubs on steep slope. Caddo Parish (10086).

**Viburnum acerifolium* L. Among rock outcrops along small open stream. Natchitoches Parish (9764).

Viburnum nudum L. In low swampy or boggy woods. Bossier (10257) and Rapides (9709) Parishes.

Viburnum rufidulum Raf. Low moist wooded bank. Natchitoches Parish (9748).

Viburnum scabrellum (T. & G.) Chapm. On railroad embankment. Tangipahoa Parish (9293).

Sambucus canadensis L. On edge of swamp. Tangipahoa Parish (10545).

Cucurbitaceae

Melothria pendula L. Trailing in swampy woods. Bossier Parish (10259).

Cayaponia Boykinii (T. & G.) Cogn. Trailing on small shrubs in open swamp. Lafayette Parish (9376).

Campanulaceae

Sphenoclea zeylanica Gaertn. In water on edge of rice field. Calcasieu Parish (9632).

Lobeliaceae

Lobelia Cardinalis L. In mud along streams or in swampy woods in open places. Caddo (10149, 10150), East Baton Rouge (10389, 10398), Lafayette (9425), Rapides (9927) and West Feliciana (10413, 10462) Parishes.

**Lobelia inflata* L. In open places of wooded ravines. West Feliciana Parish (10439, 10460).

Lobelia puberula Michx. In dry or wet soil of fields, along ditches, edge of woods or in thinly wooded areas. Bossier (10117), Claiborne (10350), De Soto (10161,

10170, 10171, 10172, 10200), Tangipahoa (10505) and Webster (10279, 10282) Parishes.

Compositae

**Vernonia altissima* Nutt. In wet soil of meadows and swamps. St. Landry (9469) and Tangipahoa (9274) Parishes.

**Vernonia missurica* Raf. Moist soil in low woods or along open ditches. Calcasieu (9629) and Winn (9998) Parishes.

Vernonia texana (A. Gray) Small. Moist or dry soil on knolls in prairies, edge of pocosins and in thinly wooded pine hills. Calcasieu (9580), Natchitoches (9760, 9810) and Vernon (9686) Parishes.

Elephantopus nudatus A. Gray. In dry or moist soil of thinly wooded areas. Natchitoches (9809), Rapides (9848) and Tangipahoa (10518) Parishes.

Elephantopus tomentosus L. Dry open-wooded slope. Rapides Parish (9994).

Eupatorium album L. Moist sandy soil in rolling pine hills. Vernon Parish (9688).

Eupatorium coelestinum L. In wet soil on edge of woods, along streams and in pine-scrub oak sandhill area. Lafayette (9424), Rapides (9860), Tangipahoa (9242), and Webster (10295) Parishes.

Eupatorium hyssopifolium L. Moist soil on edge of ditch. Calcasieu Parish (9642).

Eupatorium leucolepis T. & G. In sandy soil of savannah. Tangipahoa Parish (10536).

Eupatorium fistulosum Barratt. Low boggy soil on edge of woods. Rapides Parish (9711).

Eupatorium perfoliatum L. In moist soil on edge of low woods. Caddo Parish (10151).

**Eupatorium pubescens* Muhl. In moist soil on edge of low boggy woods. Rapides Parish (9710).

Eupatorium rotundifolium L. Sandy soil in prairie. Beauregard Parish (9674).

Eupatorium semiserratum DC. In moist cut-over woods and along roadside ditch. Bienville (10049) and Webster (10299) Parishes.

Mikania scandens (L.) Willd. Climbing on small tree. Tangipahoa Parish (9292).

Mikania scandens (L.) Willd. var. *pubescens* (Muhl.) Torr. Trailing in bushes on partly cut-over woods slope. West Feliciana Parish (10414).

Liatris elegans (Walt.) Willd. On eroded hillside. Rapides Parish (9931).

Liatris Halei (Small) K. Schum. Moist soil in fields and prairies. Beauregard (9676) and Calcasieu (9638, 9639) Parishes.

?Liatris Langloisii (Greene) Cory. Moist sandy pine slope. Tangipahoa Parish (10524).

Liatris pycnostachya Michx. Moist rocky open soil and on edge of swamp. Beauregard (9680) and Natchitoches (9951) Parishes.

**Liatris scariosa* Willd. Open dry field on edge of woods. Caddo Parish (10090).

Liatris squarrosa Willd. In dry sandy pine hills. Natchitoches Parish (9811).

Liatris squarrosa Willd. var. *intermedia* (Lindl.) DC. Open dry soil. Tangipahoa Parish (9255).

Heterotheca subaxillaris (Lam.) Britt. & Rusby. On dry open-wooded slopes and along beaches. Caddo (10087) and Cameron (9607) Parishes.

Chrysopsis graminifolia (Michx.) Nutt. Dry open pine woods. Tangipahoa Parish (9268).

Chrysopsis pilosa Nutt. In open dry pinelands. Caddo Parish (10100).

**Solidago auriculata* Shuttlew. Dry soil of thinly wooded slope. Caddo Parish (10088).

Solidago caesia L. Bank of wooded ravine. West Feliciana Parish (10410).

Solidago celtidifolia Small. In dry soil of thinly wooded pine hills. Natchitoches Parish (9807).

Solidago gigantea Ait. Moist soil in open. Tangipahoa Parish (10547).

**Solidago nitida* T. & G. In dry or moist soil in eroded areas, pine-scrub oak sandhills and pine-hardwood forests. De Soto (10211) and Rapides (9715, 9942) Parishes.

Solidago odora Ait. In rather dry soil of pine woods and cut-over forests. Natchitoches Parish (9775, 9806).

**Solidago petiolaris* Ait. var. *angusta* (T. & G.) Gray. Moist sandy soil in open stream bed. Rapides Parish (9846).

Solidago radula Nutt. In sandy dry soil along roadside. Bossier Parish (10261).

?*Solidago strigosa* Small. Dry soil of eroded places and in pine-scrub oak sandhills. Rapides Parish (9886, 9887, 9943).

**Haplopappus paniculatus* (Nutt.) T. & G. Open dry sandy scrub oak sandhills. Natchitoches Parish (9956).

**Haplopappus phyllocephalus* DC. subsp. *megacephalus* (Nash) Hall. Above high tide along Holly Beach. Cameron Parish (9618).

**Chondrophora virgata* (Nutt.) Greene. Growing in mats on flat open dry table rocks. Natchitoches Parish (9962).

**Aphanostephus skirrhobasis* (DC.) Trel. Above high tide along Holly Beach. Cameron Parish (9612).

Boltonia diffusa Ell. Moist or dry soil in open. Calcasieu (9577) and Tangipahoa (9256) Parishes.

**Aster paludosus* Ait. In sandy soil of savannahs and open rocky soil. Natchitoches (9953) and Tangipahoa (10535) Parishes.

Aster patens Ait. Sandy soil in pine-scrub oak sandhills. Rapides Parish (9714).

**Aster phyllolepis* T. & G. On small sandy knolls in prairie. Calcasieu Parish (9584).

Aster spinosus Benth. In old field. Calcasieu Parish (9568).

**Aster subulatus* Michx. var. *euroauster* Fern. & Griscom. Edge of saltwater canal. Iberia Parish (9530).

**Aster umbellatus* Mill. In a pocosin. Natchitoches Parish (9804).

Erigeron canadensis L. Dry soil along road. Lafayette Parish (9437).

**Erigeron linifolius* Willd. In sandy soil along edge of road. Cameron Parish (9621).

Pluchea camphorata (L.) DC. In wet soil along streams or in salt marshes. Iberia (9538) and Webster (10311) Parishes.

Pluchea foetida (L.) DC. In wet soil of seepage or along edge of boggy woods. Bossier (10256), Rapides (9897) and Tangipahoa (9315) Parishes.

Gnaphalium obtusifolium L. Dry sandy soil on edge of upland woods. De Soto Parish (10175).

Gnaphalium spathulatum Lam. In burnt-over soil of pine-scrub oak sandhills. Rapides Parish (9937).

Silphium asperrimum Hook. Open dry soil on low hillside. Natchitoches Parish (9791).

?*Silphium gracile* A. Gray. On small knolls in prairie. Calcasieu Parish (9574).

Silphium laciniatum L. On open dry rocky hillside. Natchitoches Parish (9948).

Parthenium Hysterophorus L. Open dry gravelly soil. St. Mary Parish (9337).

Eclipta alba (L.) Hassk. Sandy soil in flood area of the Red River. Bossier Parish (10066).

Rudbeckia alismaefolia T. & G. Sandy soil of open pine woods. Rapides Parish (9692).

Rudbeckia hirta L. Moist or dry soil in prairies, pinewoods and along railroad embankment. Calcasieu (9581), Rapides (9693) and Tangipahoa (9253) Parishes.

Rudbeckia laciniata L. Flood areas in woods along stream. Rapides Parish (9703).

Rudbeckia maxima Nutt. In dry soil of flat pine-hardwood forest. De Soto Parish (10208).

Spilanthes americana (Mutis) Hieron. Along small stream in pine woods. Livingston Parish (9172).

Borrichia frutescens (L.) DC. In salt marsh on edge of canal. Iberia Parish (9552).

Helianthus angustifolius L. In moist or dry sandy soil on knolls in prairie and in open fields. Calcasieu (9588), De Soto (10185) and Tangipahoa (10548, 10530) Parishes.

**Helianthus cucumerifolius* T. & G. In dry soil along railroad embankment. Calcasieu Parish (9625).

Helianthus hirsutus Raf. In dry soil on open hillsides or in pine-scrub oak sandhills. Caddo (10081) and Rapides (9712) Parishes.

Helianthus mollis Lam. On small sandy knolls in prairies. Calcasieu Parish (9585).

Helianthus simulans E. E. Wats. In dry open soil. Tangipahoa Parish (10532).

**Coreopsis pubescens* Ell. In low boggy woods. Rapides Parish (9707).

Coreopsis tripteris L. In meadows and thinly wooded pine slopes. Rapides (9845), Tangipahoa (10510) and Webster (10280) Parishes.

Marshallia graminifolia (Walt.) Small. Low moist grassy soil of savannahs or along ditches. Beauregard (9670) and Natchitoches (9787) Parishes.

Helenium tenuifolium Nutt. Moist open grassy meadow. Lafayette Parish (9421).

Gaillardia chrysantha Small. Moist open sandy pine woods. Vernon Parish (9689).

Gaillardia lanceolata Michx. On small sandy knolls in prairies. Calcasieu Parish (9579).

Gaillirdia pulchella Foug. Sandy soil along Holly Beach. Cameron Parish (9604).

Cirsium altissimum (L.) Spreng. (form). Edge of low moist woods. East Baton Rouge Parish (10400).

Cirsium horridulum Michx. Moist soil in low open pastureland. St. Landry Parish (9476).

Cirsium muticum Michx. On moist slope, border of pocosin and pine woods. Tangipahoa Parish (10512).

**Cirsium Nuttallii* DC. Dry soil on edge of woods. West Feliciana Parish (10442).

Lactuca canadensis L. In dry soil along railroad embankment and in pine-scrub oak sandhills. Calcasieu (9627) and Rapides (9885) Parishes.

Lactuca floridana (L.) Gaertn. On edge of wooded ravine. West Feliciana Parish (10411).

Pyrrhopappus carolinianus (Walt.) DC. Low wet soil along small stream in pasture. Lafayette Parish (9423).

Hieracium Gronovii L. Dry soil in open or in pine-hardwood forests. De Soto (10212), Ouachita (10369) and West Feliciana (10443, 10468) Parishes.

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The Status of Eleocharis parvula var. anachaeta (Torr.) Svenson

Charles Gilly

While working on a forthcoming paper on the Cyperaceae of Iowa, it became necessary to examine specimens of *Eleocharis parvula* (R. & S.) Link., and of its var. *anachaeta* (Torr.) Svenson, in order to establish the identity of an Iowa specimen which seemed referable to either this species or its variety. Inasmuch as a part of the results of the study have no bearing on or relation to the Iowa paper, it has seemed advisable to present my conclusions in this short paper.

By way of brief review, here are the more important historical facts regarding the var. *anachaeta*. First mention of this plant is by Torrey (6) in 1836: "*E. pygmaea*, p. 313. *β ? anachaeta;* nut without bristles at the base. HAB. Near New Orleans, *T. Drummond!*" The next reference is also by Torrey (7) in his report on the plants collected by the Nicollet expedition: "*Eleocharis pygmaea* (Torr. Mon. N. Amer. Cyp., 1. c.) Var., nut without bristles. Borders of ponds in prairies of Jacques river; July 9." In 1862, Buckley (2) described *Chaetocyperus membranaceus*, basing his description on a specimen of his own from Llano Co., Texas; later in the same year Asa Gray (3) wrote: "*Chaetocyperus membranaceus* is *Eleocharis pygmaea* Torr., the variety with naked achenia noticed in Nicollet's report."

Because of the obscure and sub-capitate nature of the tubercle, Britton and several other American botanists have considered *E. parvula* and its related species as belonging to the genus *Scirpus;* it was, thus, natural that Britton (1) should describe Colorado specimens of such an *Eleocharis*, as *Scirpus coloradoensis*. Svenson, in 1929 (4), raised Torrey's var. *anachaeta* to the rank of a species, naming it *E. leptos;* at the same time he referred Britton's *S. coloradoensis* to *E. leptos* as a variety, and isolated a California plant as a new variety. The name *E. leptos* was shown to be untenable because of an African species which had been previously published as *E. Lepta* C. B. Clarke, and in 1934 Svenson (5) combined his *E. leptos* and its two varieties as *E. parvula* var. *anachaeta*, thus bringing matters essentially back to agreement with Torrey's 1836 views.

The type specimens of *E. pygmaea* var. *anachaeta*, *Chaetocyperus membranaceus* and *Scirpus coloradoensis* are in the herbarium of the New York Botanical Garden. My examination of these type specimens and of a large number of specimens of *E. parvula* from both North America and Europe, has convinced me that *E. parvula* var. *anachaeta* — as understood by Svenson (5) — is an aggregate consisting of the following two distinct species, neither of which is particularly closely related to *E. parvula* (R. & S.) Link.

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Scirpus leptos Wright, in Sauv. Anal. Acad. Cien. Med. Habana **8**:80. 1871.
Scirpus nanus var. *anachaetus* (Torr.) Britton, Trans. N. Y. Acad. Sci. **9**:75. 1892.
E. leptos (Steud.) Svenson, Rhodora **31**:176, in part. 1929. Not *E. Lepta* C. B. Clarke, 1900.
E. parvula var. *anachaeta* (Torr.) Svenson, Rhodora **36**:386, in part. 1934.

Plants 2-8 cm. tall; culms filiform; basal sheaths membranous, truncate to sub-truncate at apices; spikelets 3-4 mm. long, 1-1.5 mm. in diam., 4-6-flowered; lowermost glume empty, ½—⅔ as long as the spikelets, oblong, obtuse at apex, with a prominently striate green mid-area and brownish, more or less striate, sides; fertile glumes similar, lanceolate to oblong, obtuse to acute at apices; achenes dark brown to blackish brown, faintly cellular-pitted to entirely smooth-surfaced, 1-1.1 mm. long, 0.75-1 mm. broad, broadly obovoid trigonous, the inner face much broader than the other two, the angles conspicuously ridged or keeled; apex of achene abruptly constricted into and confluent with the inconspicuous gray-green, triangular-conic, persistent tubercle (style-base); perianth bristles lacking or 1-3 minute rudiments sometimes present. (Fig. 1., *a. b*).

Specimens examined: UNITED STATES: Louisiana: New Orleans, *Drummond 409* (the type of *E. pygmaea* var. *anachaeta*); New Orleans, *Hale 56*. Texas: Bexar Co., San Antonio, *Clemens 381*; Cameron Co., Brownsville, *Runyon 1119*; Jackson Co., Alligator Lake, *Drushel 10619*; Llano Co., *Buckley* (the type of *Chaetocyperus membranaceus*). MEXICO: Sinaloa: Mazatlan, *Rose, Standley & Russell 14105*. Vera Cruz: Pueblo Viejo, *Palmer 433*. CUBA: exact locality unknown, *C. Wright*. Pinar del Rio: Orozko, near Cabañas, *Ekman 10567*.

These localities are indicated by black circles on the map (Fig. 1). Svenson (4) cites a specimen of *E. leptos* from Venezuela: "tidal lagoons, Santa Rosa near Maracaibo, *Pittier 10485*, in part (a fragment mixed with *E. maculosa*)." This fragment may, perhaps, prove to be referable to *E. membranacea*.

2. **Eleocharis coloradoensis** (Britton) comb. nov.

Scirpus coloradoensis Britton, Torreya **4**:93. 1904.
E. leptos (Steud.) Svenson, Rhodora **31**:176, in part. 1929. Not *E. Lepta* C. B. Clarke, 1900.
E. leptos var. *coloradoensis* (Britton) Svenson, Rhodora **31**:177. 1929.
E. leptos var. *Johnstonii* Svenson, Rhodora **31**:177. 1929.
E. parvula var. *anachaeta* (Torr.) Svenson, Rhodora **36**:386, in part. 1934.

Plants 2-6 cm. tall; culms filiform; basal sheaths membranaceous, obliquely acute at apices; spikelets 2-5 mm. long, 1-2 mm. in diam., 3-8-flowered; lowermost glume empty, ⅓—½ as long as the spikelets, ovate, rounded at apex with a prominently striate green mid-area and brownish, more or less membranous, sides; fertile glumes similar, lanceolate to ovate-lanceolate, rounded or obtuse at apices; achenes dark brown, deeply cellular-pitted, the surface appearing papillose or subverrucose, 0.8-1 mm. long, 0.5-0.6 mm. in diam., obovoid-trigonus, the three sides approximately equal, the angles obscurely ridged; apex

of achene abruptly constricted into a short but conspicuous triangular platform on which the greyish, pyramidal tubercle (style-base) is persistent; perianth-bristles never present. (Fig. 1., *c*, *d*).

Specimens examined: Iowa: Clay Co., Freeman Twp., *Hayden 690* (ISC, NY)[1]. South Dakota: borders of ponds in prairies near James River, *Geyer* (Nicollet Expedition). Colorado: Larimer Co., Shore Lake, *Cowen 2576* (the type of *Scirpus coloradoensis*); Weld Co., New Windsor, *Osterhout*. Nevada: Elko Co., Elko,*Kennedy 4502*. New Mexico: "near 35th parallel, Fort Smith to the Rio Grande." *Bigelow*.

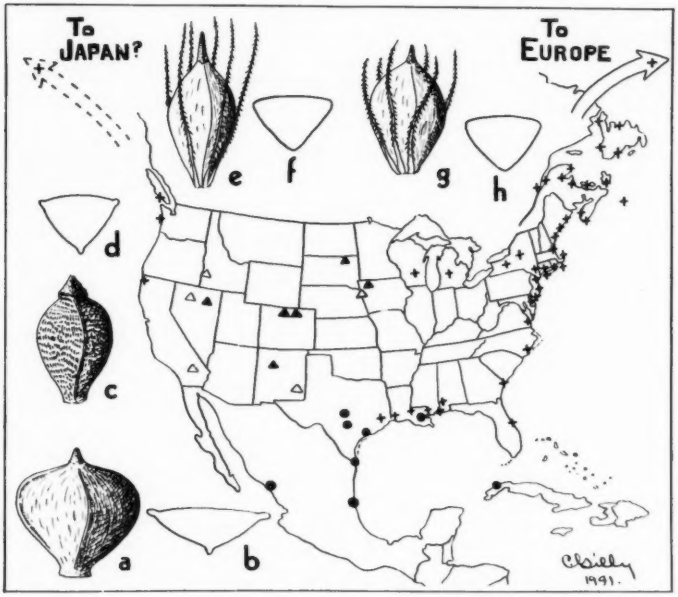

Fig. 1.—*Eleocharis membranacea* (Buckley) Gilly: a—achene (×20), b—cross-section of achene (drawn from *Drummond 409*, the type of *E. pygmaea* var. *anachaeta* Torr.); black circles represent localities from which specimens have been examined.

Eleocharis coloradoensis (Britton) Gilly: c—achene (×20), d—cross-section of achene (drawn from *Cowen 2576*, the type of *Scirpus coloradoensis* Britton); black triangles represent localities from which specimens have been examined, white triangles represent additional localities from which the species has been reported.

Eleocharis parvula (R. & S.) Link.: e—achene (×20), f—cross-section of achene (drawn from *Pringle*, mouth of the St. Lawrence River); g—achene (×20), h—cross-section of achene (drawn from *Tracy 110*, Ocean City, Mississippi); distribution of the species indicated by black crosses.

[1] Specimens of this number are in both the herbarium of Iowa State College, Ames, Iowa, and the herbarium of the New York Botanical Garden. All other specimens cited in this paper are in the latter herbarium.

These localities are indicated by black triangles on the map (Fig. 1); several other localities cited by Svenson (5) and shown on his map are indicated by white triangles on my map. I have not seen the specimen on which Svenson based his *E. leptos* var. *Johnstonii*, but his illustration (4, *pl. 189*) of this variety clearly indicates that the plant should be referred here.

For comparison between the two species described above and *E. parvula*, I have made drawings of typical achenes of the latter species (Fig. 1., *e*, *f*, *g*, *h*) from specimens representative of the northern and southern ends of its North American range. Achenes of European specimens are scarcely distinguishable from those of the American plants. In habit, *E. parvula* is very similar to *E. membranacea* and *E. coloradoensis;* its principal differences are the whitish to pale brown, essentially smooth-surfaced, broadly fusiform-trigonous achenes (the three faces of which are essentially equal, and the angles of which are not at all ridged) which are confluent with and taper into the conical tubercle, and the presence of 6 retrorsely-barbed perianth bristles which usually exceed the achene in length. Rarely these bristles are shorter than the achene or reduced to mere rudiments.

E. parvula (which has also been known in American botanical literature as *E. pygmaea, Scirpus pygmaeus* and *Scirpus nanus*) has a wide distribution in Europe and is said to occur in Japan. The North American distribution of *E. parvula*, based partly on the specimens in the herbarium of the New York Botanical Garden and partly on Svenson's map (5), is shown by crosses on my map (Fig. 1). It will be observed that the southern end of the range of *E. parvula* overlaps the north-eastern part of the range of *E. membranacea;* both species, however, maintain their own characteristics in this area. *E. parvula*, at least in North America, seems to be confined to the salt marshes of the sea coast or around salt-licks and salt-springs in the interior. *E. membranacea* is found either in salt marshes, or in alkaline areas inland, and *E. coloradoensis* apparently is confined to alkaline or calcareous habitats.

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Notes on Wisconsin Grasses—II

Muhlenbergia and Sporobolus[1]

L. H. Shinners

The group of species in *Muhlenbergia* including *M. sylvatica, M. foliosa* and *M. mexicana* has long been a source of trouble. *Muhlenbergia foliosa* is the worst offender. Plants growing in marshy open ground or damp thickets are generally characteristic enough to be easily recognized: leaves less than 10 cm. long, spikelets closely bunched on uniformly short pedicels 0.5 mm. or less long, panicle lobed or irregularly constricted. But these grade into pants of tamarack bogs or swampy woods with leaves as much as 15 cm. long, spikelets on pedicels of varying lengths, sometimes 5.0 mm. long, panicle uniformly slender and loose, the whole plant closely imitating *M. sylvatica.* The latter may be recognized by its shorter, broader, more abruptly pointed glumes, which resemble those of *M. tenuiflora,* placing it with that species and *M. sobolifera* rather than with *M. foliosa,* despite superficial resemblances between *M. foliosa* and *M. sylvatica.* These species and their relatives may be distinguished as follows:

Glumes less than 4 times as long as wide, 0.8-1.3 mm. wide (measured from margin to margin), equalling or shorter than the lemma, rather abruptly narrowed to the apex

Lemmas 2-2.6 mm. long; culms smooth below the notes. ..... *M. sobolifera*

Lemmas 2.8-4.0 mm. long; culms pubescent or roughened below the nodes

Some or all the sheaths pilose; leaf blades 6-15 mm. wide. ..... *M. tenuiflora*

Sheaths all glabrous; leaf blades 3-7 mm. wide. ..... *M. sylvatica*

Glumes more than 4 times as long as wide, 0.4-0.8 mm. wide, equalling or exceeding the lemma, tapering from near the base to the apex.

Glumes acuminate but not bristle-tipped, equalling or slightly exceeding the lemma

Culms roughened below the nodes with minute retrorse hairs. ..... *M. foliosa*

Culms smooth below the nodes (sometimes mottled or discolored and appearing as if roughened). ..... *M. mexicana*

Glumes with bristle tips half or more again as long as the lemma. ..... *M. racemosa*

Excepting *M. sylvatica* and *M. foliosa,* the vegetative characters of the species are quite distinctive, and it is sometimes possible to distinguish them by these alone:

Rhizomes sparingly or freely branching, with scales usually persisting more than a year; culms freely branching, abruptly differentiated from the rhizomes.

Rhizomes loosely and remotely branching; culms usually arising 3-10 cm. apart.

Rhizome scales 4-6 mm. long; culms smooth below the nodes. ..... *M. sobolifera*

[1] For the use of specimens examined in these studies, I am indebted to Mrs. Agnes Chase and Dr. W. R. Maxon of the United States National Herbarium, to Mr. A. M. Fuller of the Milwaukee Public Museum, and to Mr. S. C. Wadmond of Delavan, Wisconsin.

Rhizome scales 5-10 mm. long; culms pubescent below the nodes. .....*M. tenuiflora*

Rhizomes usually closely branching and bunched; culms usually arising less than 5 cm. apart.

Rhizome scales 2-7 mm. long; culms roughened below the nodes. .....*M. sylvatica* and *M. foliosa*

Rhizome scales 5-10 mm. long; culms smooth below the nodes. .....*M. mexicana*

Rhizomes usually simple or sparingly branching, with scales usually disintegrating within a year, leaving raised ring scars; culms simple or sparingly branching (except in shade forms), continuous with the rhizome, not abruptly differentiated. .....*M. racemosa*

Muhlenbergia sobolifera (Muhl.) Trin. and *M. tenuiflora* (Willd.) B.S.P. have erect culms branching near the middle and above. The two species are locally abundant on rocky wooded hillsides and bluffs in the southern quarter of Wisconsin.

Muhlenbergia sylvatica Torr. has the rhizomes of *M. foliosa,* but culms and spikelets more like those of *M. tenuiflora.* The figure of the glumes in Hitchcock's *Manual* is not at all typical. In Wisconsin the plant grows on wooded hillsides and ravine sides rather than in damp woods. It has been collected in Grant, Crawford, Sauk and Dane Counties, in the southwestern part of the state. The awnless form, f. *attenuata* (Scribn.) Palm. & Steyerm., is not known to occur in Wisconsin. Collections reported under this name in a previous paper (Amer. Midl. Nat. 24:759, 1940) are now referred to shade forms of *M. foliosa.*

Muhlenbergia foliosa (R. & S.) Trin. is our most abundant and widespread species, occurring throughout the state in marshy open ground, damp thickets, woods, and along railroad embankments. The culms are erect, and usually branch freely from well below the middle. The panicle is extremely variable in size and compactness. Shade forms resembling *M. sylvatica* have nodding or drooping panicles; in *M. sylvatica* the panicles are erect or nearly so.

Muhlenbergia mexicana (L.) Trin. grows in damp thickets and bottomlands in the southwestern half of the state. It occasionally appears in railroad yards, or as a weed in gardens. The culms are commonly bushy-branched from near the base, and sprawling or reclining.

Next to *M. foliosa, Muhlenbergia racemosa* (Michx.) B.S.P. is our commonest species, occurring throughout the state in damp or dry usually sandy ground. Ordinarily the culms are erect and simple or very sparingly branching, but may be decumbent in shade forms and branch from all the nodes.

Sporobolus is represented in Wisconsin by six species with several very different kinds of ecological behavior.

Sporobolus neglectus Nash is a rare native of gravelly hillsides in the southern tiers of counties. It is now becoming common along roadsides and railroads in the southern part of the state, and has been collected as far north as Marinette County. The plant is apparently becoming more common through invasion from outisde rather than through expansion or spread from colonies

inside the state. In Dane County it grows on steep hillsides north of Madison, but not along neighboring roadsides, nor along railroads in the vicinity of Madison; while near Paoli, in the southern part of the county, it is abundant along the Illinois Central Railroad. It is an abundant roadside weed in parts of northern Illinois near the Wisconsin boundary.

Sporobolus vaginiflorus (Torr.) Wood, like *S. neglectus* is a rare native, represented in the University Herbarium by only three collections, all from the southwestern part of the state: Sandstone bluff, Iowa Co., Lone Rock, *Fassett 2489,* Oct. 10, 1925. Limestone bluff, Roxbury, Dane Co., *Fassett 7589,* Sept. 29, 1928. Bluff between Nelson Dewey Park and Bridgeport, Grant Co., *Fassett 17609,* Sept. 28, 1934.

Sporobolus vaginiflorus var. *inaequalis* Fernald (Rhodora 35:109, 1933) is a more northern race that apparently was once rather rare in Wisconsin. Lapham (1853) does not mention any grass referable to this for the state, and the University Herbarium contains only three collections made before 1900. Judging from stations now known, it was originally found about rock ledges and outcrops north as far as Polk and Green Lake Counties. At present it is abundant nearly throughout the state in dry open ground and pastures, and along roadsides and railroads. Its spread has been largely recent. Of thirty-four collections examined, three were made before 1900, none from 1901 to 1910, five from 1911 to 1920 four from 1921 to 1930, and ten from 1931 to 1939. Most of the 1931-40 colletcions came after the severe drought year of 1934: one in 1934, none in 1935, one in 1936, one in 1937, four in 1938, three in 1939, twelve in 1940 (the 1940 figure due maily to increased collecting). The coincidence of the plant's increase with the 1930-40 decade of drought years and particularly the years following 1934 is striking. In view of its preference for dry soils, it seems probable that drought played an important part in bringing about its present abundance. In Milwaukee County its appearance and spread came largely if not wholly after 1934. This was true of *Eragrostis pectinacea,* a plant of nearly identical history and behavior which was rare about Milwaukee in 1937, but is now an abundant weed.

In some places there has been a spread of *Sporobolus vaginiflorus* var. *inaequalis* from native colonies. South of Marquette, in Green Lake County, it grows with *Aristida basiramea* on granite outcrops, but both plants have become much more abundant on adjacent level pasture lands. In most parts of Wisconsin, however, the greatest abundance of the *Sporobolus* occurs along roadsides and railroads, and with few exceptions there is no indication that plants in these situations are derived from local native colonies. Like *S. neglectus, Sporobolus vaginiflorus* var. *inaequalis* is represented in Wisconsin by a population of mixed origin. Its present distribution probably is a later stage of the sort of invasion now being made by *S. neglectus.*

Sporobolus asper (Michx.) Kunth was found along railroads in Bayfield, Fond du Lac and Sheboygan Counties in 1940, in addition to previously known stations in Milwaukee and Dane Counties. In Milwaukee County it appeared to be increasing in abundance. South of Cudahy it formed a solid

stand for three quarters of a mile along the Chicago and Northwestern Railroad, growing in cinders used for ballast. Soil tests made during 1940 gave alkaline reactions for both cinders and coal dust, the pH ranging from 7.5 to 8.5. This may account for the occurrence of several western alkaline soil grasses in the vicinity of railroads in Wisconsin: *Muhlenbergia asperifolia* at Milwaukee, Fond du Lac and Sheboygan; *Leptochloa fascicularis* at Milwaukee (abundant in 1940); *Agropyron Smithii* throughout the southern third of the state. In some cases dryness is an important factor, but this hardly applies to *Muhlenbergia asperifolia*, a plant of moist soils.

Sometimes these western grasses find suitable habitats other than railroad ballast. Southeast of Slinger, in Washington County, *Agropyron Smithii* is common in ballast along the Soo Line tracks, and where these are crossed by town roads surfaced with crushed limestone, it is spreading onto the roadsides.

Sporobolus clandestinus (Spreng.) Hitchc. has not been previously reported from Wisconsin, and as yet is known from a single station: Low sand hill 2 miles south of Bell Center, Crawford County, *Fassett, Catenhusen & Shinners 20693*, Sept. 15, 1940. It grows apparently as a native on one of the small relic prairies of the Driftless Area, in company with *Andropogon scoparius, Leptoloma cognatum, Lespedeza capitata* and *Solidago speciosa*. Though abundant, it is confined to an area no larger than an ordinary city block.

Sporobolus heterolepis A. Gray is a plant of climax prairie, very sedentary, not at all weedy, and not known to migrate over long distances. Its spread during recent years has been very slight, and confined to the vicinity of relics of original prairie (cf. Thomson, 1940). The Wisconsin population is probably entirely indigenous. All our other species of *Sporobolus* except *S. clandestinus* belong to early stages of plant succession, are highly motile, are weedy, have spread extensively, and are represented by plants of both native and alien origin.

Sporobolus cryptandrus (Torr.) A. Gray was originally found along Lake Michigan and locally in sandy areas in the southern and western parts of the state, probably where these were not occupied by climax prairie or scrub. Like *S. vaginiflorus* var. *inaequalis*, it apparently was rather rare. Lapham does not list it, and it is represented in the University Herbarium by only six scattered collections made before 1900. It is now an abundant weed in sandy areas, particularly in central and western Wisconsin, and is found locally along roadsides and railroads as far north as Bayfield, Marinette and Door Counties. Again like *S. vaginiflorus* var. *inaequalis*, much of its present distribution is due to plants of alien origin, or at least to plants from distant parts of the state. This is sometimes true even in places where it at one time occurred as a native. It was formerly found on the Lake Michigan beach at Bay View, Milwaukee County, on the south side of Milwaukee harbor (Brues, 1911). It has been exterminated there, but in the past three years has appeared along the Chicago and Northwestern Railroad tracks at two points within half a mile of Bay View. Thus *Sporobolus cryptandrus* was a member of the Mil-

waukee flora in 1910, and again in 1940, but the populations at the two periods were of entirely different origins.

These six species exemplify some of the changes occurring in the plant populations of Wisconsin. There is a general movement into the state from the south and west. Very motile or weedy species are the first to appear, and as yet they are almost the only ones. Some of them may be native within the state in scattered colonies, apparently as relics of former more widespread occurrence, but the bulk of recolonization comes from main centers of abundance, not from these small isolated colonies, even though they may be closer. Railroads and roadways are important avenues of immigration. Special factors affecting the establishment of invaders are drought, soil, time, and the removal of other plant cover by man.

The immigration of plants from prairie regions does not mean the immediate establishment of climax prairie. This requires the appearance of climax species, many of which are sedentary, and accomplish migration chiefly by slow marginal spread. The occurrence of small relics of climax prairie away from the main body of prairie is in the long run of great importance in recolonization; the occurrence of scattered colonies of weedy species is not. All climax species, however, do not behave in the slow manner that *Sporobolus heterolepis* does, and *Sporobolus heterolepis* itself may yet show a different type of behavior. In the past three years *Silphium laciniatum*, usually a very sedentary species, has invaded Milwaukee County and established itself along railroad rights-of-way, moving at least twenty-five miles to do so, and possibly much farther if it spreads in the same fashion as the weedy grasses.

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First Supplement to the Flora of Mount Shasta

William Bridge Cooke

A. 1940 Additions to the List

During the summer of 1940 the writer continued field studies on the flora of Mount Shasta and has added a number of species and genera as well as one family to the recently published flora of that mountain (3).

In addition to covering familiar territory including the Sisson Southern Trail, the Horse Camp-Wagon Camp Trail, the Wagon Camp Road, areas on a contour line between Horse Camp and Squaw Valley Creek, and parts of Mud Creek Canyon, new territory was visited. This included trips through the chaparral belt on the north side of the mountain up the lanes from Bolam and Hotlum Stations on the Southern Pacific Railroad; a trip down Diller Canyon from 10,000 feet; a trip down Squaw Valley Creek to the big spring, the source of water supply of the McCloud River Lumber Company; and further exploration of Mud Creek Canyon especially in the vicinity of Clear Creek.

The extension of range of many species has thus been recorded by herbarium specimens while 1 family, 21 genera and 62 species are added to the first list.

Ophioglossaceae

Botrychium pumicola Coville. Pumice Grapefern.—Material referred tentatively to this species by Dr. Robert Clausen was collected in a small lava flat near the south wall of Diller Canyon. One specimen was obtained. Through further search it is possible that more will be found. The only other records of the species, Crater Lake and the Paulina Mountains of Oregon, indicate an interesting area of endemism for this species.

Equisetaceae

Equisetum hyemale L. var. *robustum* (A.Br.) A. A. Eat. Scouring Rush.—A large colony was found around the outlet of the big Squaw Valley Creek spring. Plants were scattered through the rather dense thickets and forest of the Transition Zone.

Cupressaceae

Juniperus californica Carr. var. *utahensis* Engelm. Desert Juniper.—Occasional trees were found as high as 4000 feet along the Weed-Klamath Falls Highway on the north side of the mountain. They grow in the transition area between the Upper Sonoran juniper woodlands of the Shasta Valley and the Transitional Chaparral of the lower altitudes of the mountain.

Gramineae

Koeleria cristata (L.) Pers. June Grass.

Oryzopsis hymenoides (Roem. & Schult.) Ricker. Indian Rice Grass.—These grasses grow in sandy areas near the Weed-Klamath Falls Highway and along the Bolam lane in the area in which the Junipers were found.

Melica bulbosa Geyer. Onion Grass.—Found occasionally near Wagon Camp.

Cinna latifolia (Trev.) Griseb. Drooping Woodreed.

Calamagrostis canadensis (Michx.) Beauv. Canadian Blue-Joint.—These grasses were frequent in the beds of Clear and Mud Creeks as well as in spring areas along Mud Creek above 6000 feet.

Cyperaceae

Carex Bolanderi Olney. Bolander's Sedge.—On the banks of Squaw Valley Creek below the falls.

Carex integra Mkze. Perfect Sedge.—Along the creeks at Bear Springs.

Carex luzulina Olney. Wood-rush Sedge.—In small meadows along Squaw Valley Creek.

Carex multicaulis Bailey. Many-stemmed Sedge.—In dry woods in the Canadian Zone under Shasta Fir and mixed conifer woods.

Juncaceae

Juncus effusus L. var. *pacificus* Fern. & Wieg. Pacific Bull Rush.—Common around the Black Butte Spring.

Luzula parviflora Desv. Few-Flowered Wood-Rush. — Common along Squaw Valley Creek below the McCloud water supply intake.

Orchidaceae

Goodyera decipiens (Hook.) Hubbard. Rattlesnake Orchid.—One plant was found in a Dogwood thicket below the big Squaw Valley Creek Spring.

Fagaceae

Quercus chrysolepis Liebm. Golden Cup or Maul Oak.—One shrub, identified by Dr. McMinn as a crown sprout, was found along the road in the Lava Park above Hotlum Station.

Carophyllaceae

Silene Menziesii Hook. Menzies's Catch-fly.—A colony was found near the Wagon Camp Road between Wagon Camp and Bear Springs.

**Stellaria crispa* C. & S. Crisped Chick-weed.—Common around springs in Mud Creek Canyon above and below the outlet of Clear Creek.

Berberidaceae

Berberis Piperiana (Abrams) McMinn. Piper's Oregon Grape.—Common

in the chaparral and among large blocks of lava in the Lava Park above Hotlum Station and around to the north side of Diller Canyon.

Berberis nervosa Pursh. Mountain Oregon Grape.—Common in the narrow tongue of dense Transition Zone forest extending down the mountain in the valley of Squaw Valley Creek below the big spring.

Leguminosae

Astragalus Whitedii Piper. Whited's Rattle Pod.—Several plants occur on the north side of the mountain along the road above Bolam Station.

Lotus crassifolius (Benth.) Greene. Fleshy or Thick-leaved Lotus.—A large colony occurs around the Black Butte Spring.

Lupinus albicaulis Dougl. White-stemmed Lupine.—Specimens referred to this species, rather than to the variety *shastensis*, were collected in the Shasta Fir woods above Wagon Camp.

Lupinus laxiflorus Dougl. Blue Lupine.—*L. laxiflorus* Dougl. var. *silvicola* (Heller) C. P. Smith.—*L. lepideus* Dougl. var. *Torreyi* (Gray) Jepson. Torrey's Lupine.—These species were collected on the north side of the mountain in the chaparral and along the Southern Pacific Railroad near Hotlum and Bolam Stations.

Euphorbiaceae

Euphorbia crenulata Engelm. Spurge.— A large colony grows along the Memorial Highway in a cut through the Chaparral Belt.

Anacardiaceae

Rhus trilobata Nutt. Squaw Bush.—Occasional shrubs occur in the lower elevations on the north side of the mountain near Bolam Station.

Malvaceae

Iliamna Bakeri (Jepson) Wiggins. Baker's Bush Mallow.—Several shrubby plants occur along the new Memorial Highway in the chaparral.

Violaceae

Viola lobata Benth. var. *integrifolia* Wats. Pine Violet.—Frequent on the ground under shrubbery along Squaw Valley Creek near the lower end of the dry canyon.

Onagraceae

Clarkia rhomboidea Dougl. Clarkia.—Common throughout the chaparral belt, especially near MacBride Springs.

Epilobum paniculatum Nutt. Chaparral Willow-Herb.—Common in the chaparral around MacBride Springs.

Gayophytum diffusum T. & G.—*G. lasiospermum* Greene.—*G. Nuttallii* T. & G.—Found commonly along the new Memorial highway in the chaparral as well as at other stations in the same type of habitat.

Gayophytum Helleri Rydb. var. *glabrum* Munz.—Common in sandy openings in Squaw Valley Creek meadows.

Gayophytum humile Juss. var. *typicum* Munz.—One plant was found in the bed of Mud Creek Canyon.

(Probably material referred to as *Gayophytum ramosissimum* in the Flora largely belongs to these five species.)

Gentianaceae

Swertia albicaulis Dougl.—Common in chaparral and openings along the old Hotlum Road near its terminus in chaparral and remnants of pine woods.

Polemoniaceae

Gilia congesta Hook.—*G. leptalea* (Gray) Greene.—*G. leptomeria* Gray. —In sandy places and among lava blocks on the north side of Mt. Shasta above Hotlum and Bolam Stations.

Leptodactylon pungens (Torr.) Jepson. Prickly Phlox.—Frequent in open sandy places in the chaparral on the north side of the mountain above Hotlum Station. (Commoner as the elevation decreases.)

Hydrophyllaceae

Nama densum Lemmon.—Common in the old logging road going up the mountain from Bolam Station.

Phacelia linearis (Pursh) Holz. Blue Phacelia.—Common at the lower end of Bolam Road.

Boraginaceae

Lithospermum ruderale Dougl. Puccoon.—Several plants were observed in the open chaparral on the north side of the mountain above Hotlum and Bolam Stations.

Labiatae

Monardella odoratissima Benth. ssp. *pallida* (Heller) Epling. Pale False Pennyroyal.—Occasional on the mountain with the species.

Pycnanthemum californicum Torr. California Mountain-Mint.—A colony occurs around the Black Butte Spring.

Scrophulariaceae

Castilleja pruinosa Fern. Indian Paint-Brush.—Scattered among the lava blocks in the Lava Park above Hotlum Station.

Mimulus rubellus Gray var. *Breweri* (Gray) Jepson. Purple Monkey-Flower.—Colonies are frequent in the Canadian Zone sand flats as well as in sandy places in all zones below 7000 feet. One-flowered plants were found on lava flats on Shastina near the south side of Diller Canyon.

Pentstemon laetus Gray ssp. *sagittatus* Keck. Narrow-Anthered Beard-Tongue.—Material was collected along the old Bolam Road on the north side of the mountain, and a large colony was found at the junction of the Wagon Camp Road and the Memorial Highway.

Pentstemon Lemmonii Gray. Lemmon's Beard-Tongue.—A colony was found near the lower end of the dry portion of Squaw Valley Creek Canyon.

Orobanchaceae

Orobanche fasciculata Nutt. Fascicled Broom-rape.—Frequent in the dry meadow near the source of MacBride Springs in association with *Phacelia* spp. and grasses.

Caprifoliaceae

Linnaea borealis L. var. *americana* Rehder. Twin Flower.—Common on the floor of the dense Transition Zone woods along lower Squaw Valley Creek below the big spring.

Compositae

**Antennaria Geyeri* Gray. Geyer's Everlasting.—Large mats were found scattered among the chaparral and the remnants of the Transition Zone yellow pine woods in a small basin in the Lava Park above Hotlum Station.

Anthemis Cotula L. Mayweed.—One plant was found at Bear Springs where a number of weeds are being rapidly introduced.

Aster Eatonii (Gray) Howell. Eaton's Aster.—Frequent in the meadow area at Black Butte Spring.

**Aster shastensis* Gray. Shasta Aster.—Additional material of this species, collected in 1940, indicates that it is one of the most wide spread species on the mountain. A narrow-leaved form was collected at the foot of Diller Canyon; dwarf, mat-forming specimens had been collected in subalpine areas; larger specimens were found throughout the Hudsonian and Canadian Zones. In the Flora a species reported as *Aster* cf. *leucanthemifolius* was mentioned as having been found in the chaparral along the MacBride Springs road. In 1940 more material of this type from along the Memorial Highway, a few hundred feet from the MacBride Springs road location but geographically continuous with it in the chaparral, was collected. When Dr. Blake studied this material this year he came to the conclusion that it was a part of the *Aster shastensis* complex.

Brickellia grandiflora (Hook.) Nutt. Large-Flowered Brickellia.—A small colony of plants in bud was found among piles of lava in the Lava Park above Hotlum Station.

Crepis acuminata Nutt. Hawksbeard.—Scattered through sandy areas below Bolam Station.

Eriophyllum lanatum (Pursh) Forbes var. *achillaeoides* (DC.) Jepson. *E. lanatum* (Pursh) Forbes var. *integrifolium* (Hook.) Smiley.—Found on the northwest quadrant of the mountain between the Bolam Road and Diller Canyon usually in the chaparral belt but extending up through the Transition Zone.

Hemizonella minima Gray.—Common in an old road leading to an abandoned logging camp from Bolam Station.

A Report on Incidental Collections of Cryptogams

In addition to flowering plants and ferns a number of other plants have been collected in connection with the floristic studies but without the idea of producing at this time a complete or even an approximately complete list of the cryptogamic flora of the mountain. These collections include algae, liverworts and mosses. Of the fungi collected a preliminary list has been presented (4).

Algae

Collections of algae are confined to the more spectacular species observable by most persons superficially interested in them. Material of a sterile species of *Zygnema* was collected among mosses near the upper end of Squaw Valley Creek. This was the only filamentous species seen in that creek. Associated with this were *Diatoms*. In an overflow pool near Squaw Valley Creek were colonies of an as yet undetermined *Desmid*. Three interesting species deserve more detailed mention.

Sphaerella nivalis (Bauer) Sommerf. Red Snow.—Red snow is common throughout the areas of the mountain on which snow lies for at least 6 months. It is frequently noted by professional, and especially amateur, mountaineers on the higher slopes when the snow is slow in melting from those areas. Material in melting snow fields collects in red streaks at the base of various layers in the snow pack, especially where those layers are resting on hard snow or ice layers.

Nostoc parmelioides B. & F.—Thalli of this interesting species are easily seen on rocks in Squaw Valley Creek and in subalpine springs when one stoops to drink from them Indian style. The greenish-black compressed thalli are attached to the smooth lava rocks in the bottom of the streams where they are continuously washed with cold spring water.

Pleurocapsa caldaria (Tilden) Setchell.—Comparatively large patches of this blue-green alga are found encrusting andesite rocks around the solfatara fumaroles at the summit of the mountain, 14,000 feet above sea level.

Hepaticae

Liverworts are seen infrequently on Mount Shasta. Thallose species have been seen in the Sisson Southern Trail Spring area and on lava sand at Wagon Camp. Both were in sterile condition.

A single determinable speciem was obtained. It occurs as a mat-former associated with *Philonotis fontana* along the mossy bank of Squaw Valley Creek in the heather meadows. This was identified by Dr. M. Fulford as *Plectocolea rubra* (Gottsche) Evans.

Musci (Mosses)

During 1940, 18 species of mosses were collected on the mountain from both stream sides along Squaw Valley Creek, on the ground in the Heather Meadows, in the Wagon Camp marsh, and on rocky exposures of gray and platy andesites. These mosses are:

Anacolia aristifolia Flowers
Brachythecium lamprochryseum C. Müll. & Kindb.
Bryum caespiticium Hedw.
Bryum cuspidatum (Bry. eur.) Schimp.
Bryum firmum Schreb.
Bryum truncorum Brid.
Funaria hygrometrica Hedw. var. *convoluta* Hampe
Grimmia alpestris Nees
Grimmia pulvinata (Hedw.) Smith
Leptobryum pyriforme (Hedw.) Schimp.
Mnium affine Bland.
Onchophorus virens (Hedw.) Brid.
Orthotrichum ruprestre Schleich.
Philonotis fontana (Hedw.) Brid.
Pogonatum alpinum (Hedw.) Rohl.
Polytrichum juniperinum Hedw.
Pseudoleskea atrovirens [Dicks.] Bry. eur.
Tortula princeps DeNot.

In addition to these, Merriam (8) reported two species which were determined by Mrs. Britton as:

Harpidium hexannulatum Gumb.
Aulacomnium androgynum Sch.

Acknowledgements for assistance in determining material listed above are made to the following persons: Dr. Robert Clausen, Dr. Jason Swallen, Dr. F. J. Hermann, Dr. Lincoln Constance, Dr. H. E. McMinn, Dr. L. C. Wheeler, Dr. P. A. Munz, Dr. H. L. Mason, Dr. C. C. Epling, Miss Alice Eastwood, Dr. D. D. Keck, Dr. S. F. Blake, Mr. J. T. Howell, Dr. Francis Drouet, Dr. Margaret Fulford and Dr. William C Steere.

B. Notes on Early Collections

As suggested by Constance (2) references to previous collections in herbaria have been meagre throughout earlier discussions by the writer on the Shastan flora. This phase of the problem has been but briefly touched upon for several reasons. While the names of various collectors are known the dispositions of their material in herbaria is not well known. For instance, a number of E. B. Copeland's 1903 collections were distributed by Baker and a sheet by sheet check would be the only means of knowing which species in this series came from Shasta. Copeland was primarily interested in Mount Eddy and his Shasta material was made up only of outstanding species, such as the type of *Polemonium shastense* Eastwood.

Further search in the herbaria of Pringle, Lemmon, Brewer, and others would, no doubt, present evidence which would increase our knowledge of the results of individual collectors.

The two largest collections made on the mountain prior to 1936 are those of H. E. Brown and C. Hart Merriam. In 1897, a year before the Merriam expedition, Brown made a number of collections on, and in the vicinity of, Mt. Shasta. He published a list of some 700 species of plants he collected in California which he issued to prospective customers. A copy of this list was found in the library of the New York Botanical Garden. There is no way of knowing by reading the list, which was made up without regard to order either alphabetical, numerical or systematic and which is replete with typographical errors which sometimes disguise the words they are supposed to represent, which plants Brown collected on his several trips in Butte Co., Shasta Co. including Mt. Lassen, and Siskiyou Co. including Mt. Shasta. A reference to the specimens, of which a complete set is on file at the New York Botanical Garden, and probably a complete set is at the National Herbarium, shows general labels for the Mt. Shasta specimens which vary in information only as to whether the material came from the north or south side of the mountain

and the date of collection. In the day spent at New York checking Brown collections 19 Shasta and 25 other specimens were examined.

Merriam (8), Wheeler (9), and Cooke (6), have remarked on the difficulties of definitely placing the locations of plants reported as having been collected "on Mount Shasta." The mountain dominates a large amount of territory including areas in the Klamath-Siskiyou-Scott Mountain region, the southwestern lava fields of the Columbia plateau, and the canyons of the Pit, McCloud and Sacramento Rivers. As pointed out in two of the cited papers the temptation was great, because of inadequate knowledge of local geographic names, to label anything collected within a considerable radius of the mountain "near," or "on" Mt. Shasta. This may account in part for some of the strange reports of Brown.

On the "South Side of Mt. Shasta" at various dates between July 1 and Aug. 15 between the elevations of 5000 and 10,000 feet (the citation is generalized rather than zoned) the following species were among those reported as collected:

Asclepias mexicana
Dicentra pauciflora
Dicentra formosa
Drosera rotundifolia
Aconitum columbianum
Actaea spicata arguta
Gentiana simplex
Paeonia Brownii

On the "North Side of Mt. Shasta" at various dates between June 11 and July 31 between the altitudes of 5000 and 10,000 feet the following species were among those reported:

Lupinus polyphyllus
Phyllodoce empetriformis
**Sedum californicum*
Sedum obtusatum
**Sedum shastense*
Asclepias speciosa
Cassiope Mertensiana
Clematis ligusticifolia
Eschscholtzia californica Douglasii
**Lupinus croceus*
Lupinus Lyallii

(*—new species based on these collections.)

Of these *Dicentra pauciflora* and *Cassiope Mertensiana* have not since been reported closer than Mt. Eddy and the Scott Mountains to the west of Mt. Shasta where they are not uncommon. *Dicentra formosa, Eschscholtzia californica, Clematis ligusticifolia, Lupinus polyphyllus, Asclepias speciosa* and *A. mexicana* have been collected in the Sacramento, Shasta or Klamath valleys at lower elevations (at most as high as 3500 feet) and in different habitats than are typical of the Shastan flora. *Lupinus croceus* has been collected several times in the Scott Mountains as reported in Miss Eastwood's description of the species (7), and the writer found it abundantly along the Castle Lake road in 1940 associated with *Lithocarpus densiflora* var. *echinoides*, another species erroneously attributed to Mt. Shasta as a common shrub (together with *Quercus vaccinifolia* it dominates the shrub communities in the Castle Crags region). *Sedum californicum* and *S. shastense* have not again been collected as such in the areaa although several other stations are reported to be known for *S. californicum*. On the basis of these observations I should like to suggest that Brown's labels carrying "Mt. Shasta" as the location of collection be interpreted in the broadest sense, i.e., as a general area possibly includ-

ing at least the eastern ranges of the Klamath Province of Siskiyou, Shasta and even Trinity Counties, rather than in the most restricted sense, i.e., Mt. Shasta itself. While this will complicate matters for the collector of topotypes it will possibly clirafy the situation and assist him when such material cannot be found on the slopes of Shasta itself.

A letter received from Mr. A. A. Heller of Chico, Calif., dated January 18, 1941, further elucidates this problem. I quote from it:

> I suppose I am responsible for the botanical activities of H. E. Brown.—I learned later that he lumped everything (collected in the region) under the heading of Mt. Shasta, although quite a bit of the collecting was done on Mt. Eddy. No doubt all of his *Sedum* collections were made somewhere on Mt. Eddy. There are places along Wagon Creek, especially. Brown collected the type of *Lupinus croceus* Eastwood, Leafl. West. Bot. 2:126, 1938, supposedly from the north side of Mt. Shasta, 5000-9000 feet elevation. I doubt if it is found there at all. I got it at at least two places on Mt. Eddy, and have never found it elsewhere.

Most of the Merriam collections not starred in the Flora or included in the appendix to that paper are now more or less better known to the writer. Some of Merriam's Shastan collections were found in the National Herbarium. Others were missing or filed under other names or not yet mounted. Time did not permit a more detailed study of this material. Notes on some of the species listed in the appendix of the earlier paper follow:

Agoseris monticola is listed as *A. scorzoneraefolia*. While Greene described *A. monticola* from material collected by Merriam on Shasta Dr. Blake feels that my collection from a number of locations known (from his itinerary) to have been visited by Merriam should, until monographic treatment of the genus is forthcoming, be referred to *A. scorzoneraefolia*.

Arnica Merriamii. Material collected along the middle Squaw Valley Creek area was reported by Dr. Maguire as the same as Greene's species which is a mere local variation of *A. mollis*.

Eriogonum polypodum. Material referred to in the list as *E. marifolium* comes from the same area and answers the same habit description as that given by Merriam for this species.

Fragaria bracteata and *F. chilensis* probably do not coincide in range with our area and our reports of *F. virginiana* and *F. californica* probably include what Merriam found.

Oreastrum alpigenum. Merriam's specimen was found in the National Herbarium and Dr. Blake's opinion is that the material is definitely that of *Aster occidentalis*.

Sarcodes sanguinea was reported by Merriam on what were supposed to be good hearsay reports. On the east side of the Sacramento Valley the species has reached the Columbia Plateau at one point north of the Pit River and therefore is not included in the Shasta flora.

Saxifraga bryophora was based on a collection from the Scott mountain region, possibly from the neighborhood of the Castle Crags.

Senecio canus in Merriam's records probably includes one or more of the species *S. cymbalarioides, S. Howellii* and *S. oreopolus.*

Vaccinium caespitosum var. *arbuscula.* At the location given for the species by Merriam no sign of such a plant was found, possibly either because of overgrazing by sheep, or because of misdetermination of the species of *Vaccinium* growing at Wagon Camp. Other shrubs at that point have been damaged or trampled especially during dry years.

One additional group of material may be mentioned. For a number of years Mr. Edward Stuhl has been making water color paintings of Shasta plants which have been exhibited in various museums throughout the state. The set now totals over a hundred species of which all but the most critical can be identified from the painting. At least one, possibly more, new records based on material observed along the ridge between Squaw Valley Creek and Mud Creek Canyons can be added to the list as soon as herbarium material is available.

A reference may be made to a recent physiological-ecological study of the effect of the Mud Creek mud flow on the surrounding forest. This was described in brief under the heading of "Geology" in the Flora (3). In 1930, 6 years after the worst part of the flow, Bearsley and Cannon (1) studied its effect on the vegetation. They found that while, after the first year, all the trees had been smothered and killed the willow shrubs had not felt the effects; and that after the 6th year even the willows had succumbed probably as a result of a change in the available water. The last 10 years have changed the aspect of the vegetation little although a certain amount of new growth is invading the devastated area from the chaparral, the islands of old growth undisturbed by the flow and along the stream which has become established in a new channel.

C. A Note on Type Specimens Reported to have been Collected on Mount Shasta

Since 1866, when the first species based on material from Mt. Shasta was described, at least 32 species, subspecies and varieties of plants have been described from various collections reported to have been made on the mountain. These fall into three groups: 1. Species in whose type description a generalized range, such as "from the vicinity of Mt. Shasta southward in the Sierra Nevada," is given leaving one in doubt as to the actual collection location. None of these has since been found on the mountain itself. 2. Species based on collections made by H. E. Brown which have not since been found on the mountain. 3. Species of general or local distribution on the mountain and which have been reported since their first collection. Some of these latter species are synonymous with species in the main list but are listed below to help clarify the situation and to bring our information of the mountain's flora up to date.

In compiling this list the writer is indebted to Dr. Lincoln Constance and the Herbarium of the University of California for the use of the California type species index file.

1. Species of indefinite range:

Streptanthus Breweri Gray
Trifolium productum Greene
Ranunculus samolifolius Greene
Sidalcea glaucescens Greene

2. Species not collected on Shasta since Brown's report:

Allocarya laxa Piper
Lathyrus Brownii Eastwood
Lupinus croceus Eastwood
Rosa Brownii Rydberg
Sedum californicum Britton ex Britton and Rose
Sedum shastense Britton ex Britton and Rose
Sisyrinchium Greenei Bicknell

3. Species rare or common on Mt. Shasta at present:

Abies magnifica Murr. var. *shastensis* Lemmon.
Aconitum platysepalum Greene—a synonym of *A. columbianum.*
Agoseris monticola Greene—tentatively referred to *A. scorzoneraefolia.*
Aplopappus (Ericameria) Bloomeri var. *angustatus* Gray—referred to under the genus *Chrysothamnus.*
Arnica Merriamii Greene—a synonym of *A. mollis.*
Arnica viscosa Gray.
Campanula Wilkinsiana Greene.
Cerasus parvifolia Greene—a synonym of *Prunus emarginata.*
Carex fracta Mkze.
Chrysopsis shastensis Jepson—a synonym of *Arnica viscosa.*
Echinospermum californicum Gray—referred to under the genus *Hackelia.*
Horkelia Brownii Rydb.—a synonym of *H. fusca* ssp. *pseudocapitata.*
Lupinus obtusilobus Heller.
Machaeranthera shastensis Gray—referred to under the genus *Aster.*
Penstemon laetus ssp. *sagittatus* Keck.
Phacelia frigida Greene.
Polemonium shastense Eastwood.
Polygonum shastense Brewer ex Gray.
Raillardella paniculata Greene—a synonym of *Arnica viscosa.*
Washingtonia brevipes Coulter and Rose—refrred to as *Ozmorhiza nuda* var. *brevipes.*
Carex straminea var. *congesta* Boott ex Olney, now known as *C. straminiformis* Bailey, was based on material collected by Brewer from the higher slopes of the mountain but has not been recollected.

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Mount Shasta,
Siskiyou Co., California.

The Morphology and Life History of Hymanella retenuova, a new Species of Triclad from New England[1]

William A. Castle

In April 1937, two collections of debris from a vernal pond near Brown University yielded a total of 25 planarians which did not appear to belong to any of the species known by me to occur in that region. Following a futile attempt to feed these worms on crushed tadpoles they died after a sojourn of but a few days in the laboratory. Two subsequent collections made during the spring of 1937 yielded some 30 additional specimens which survived up to 17 days in the laboratory and deposited over 40 egg capsules. The peculiar retention of fully formed egg capsules in the bodies of the worms for several days, the oblong shape of the capsules and the lack of an attachment stalk, together with the general shape and appearance of the planarians led me to conclude that a new species was at hand. This was confirmed by Miss L. H. Hyman, who after examination of sections and reconstructions of the copulatory apparatus which I had sent to her was also of the opinion that a new genus was necessitated for the animal. Miss Hyman also called my attention to an article by Chidester (1908) on the extrusion of "winter egg capsules" by a planarian which he identified as "*Planaria simplicissima*" (=*Curtisia foremanii*). Chidester's description and figures show at once that the planarium he observed could not possibly have been *Curtisia foremanii*, and I am convinced that it was identical with the form herein described.

The new planarian appears to require a new genus and I propose as the generic name *Hymanella*, in honor of Dr. Hyman who has contributed so much to our knowledge of the American triclads, and as the specific name *retenuova*, in reference to the habit of retaining the mature egg capsules in the body for a period of time before their extrusion.

Hymanella retenuova, n. gen., n. sp.

Material.—The observations on living worms have been made on material collected in 1937 and 1938. From specimens collected during both of these years a total of some 25 worms have been fixed and sectioned for study. Almost all of these have shown at least portions of the reproductive systems in one stage or another of development. Animals were fixed in hot mercuric chloride after being killed by a few drops of 0.5% nitric acid. Sections were stained in Iron Hematoxylin and Orange G or with Mallory's Triple Stain. Transverse

1 The work reported in this paper was carried out at Brown University and the University of Chicago.

and sagittal serial sections have been studied and from these it has been possible to reconstruct most of the parts of the reproductive system.

External characters.—General shape in motion as shown in Fig. 1. Form at rest similar to that of small resting specimens of the genus Phagocata. Head shape of low triangular form, somewhat like that of genus Curtisia, but with auricles much less developed. Body relatively short and broad, sides about parallel, tapering from region of atrium posteriorly to the bluntly pointed posterior end; anteriorly very slightly constricted at "neck" region, then broadening at auricles where width is greater than elsewhere in the body. Eyes two in number, of characteristic reniform shape with sharply marked off oblong unpigmented areas lateral and anterior to them; farther from anterior margin and more widely separated than in most American triclads. Pigmentation grayish; pigment granules evenly dispersed, not sufficiently dense to obscure the color of gut contents in animals recently fed. In some specimens many clear areas indicating the presence of large masses of gregarine parasites. Length up to 14 mm.; sexually mature at sizes above 7 mm.; length in general 5 or 6 times the greatest width.

Female reproductive system.—Ovaries between a third and two-fifths of distance from anterior end to pharyngeal chamber, generally close to the ventral surface and median to ventral nerve cords; smaller than in many other triclads, often lobulated, in some cases elongate in their antero-posterior axes, in others drawn out half way to dorsal surface. Parovaria absent or present as scattered cells with deeply staining cytoplasm, in no case observed forming compact masses as in other species. Ampullae of oviducts at dorso lateral borders and toward anterior ends of ovaries, often containing small masses of sperm; muscles of closing plate discernible but not strongly developed. Oviducts curving from ampullae sharply ventrally lateral to ovaries, thence leading posteriorly along dorso-lateral borders of nerve cords; at the level of atrium bending dorsally and medially to meet at a point dorsal to posterior end of atrium and often to the left of midline; often enlarged near point of juncture. Common oviduct leading from this point ventrally and posteriorly to open into anterior face of bursa stalk or in one specimen observed into roof of common atrium dorsal to genital pore. (See Figs. 3, 4, 5, and 8.) Yolk glands abundant between gut diverticula through anterior end of body from level of ovaries to base of pharynx, also in region posterior to atrium; openings of yolk glands into oviducts or posterior yolk ducts not seen.

Male reproductive system.—Remnants of testes present in dorso-lateral regions of body from level of ovaries to base of pharynx; apparently markedly protandrous, since presence of sperm in oviducts, bursa stalk and seminal vesicles of most specimens indicates copulation has taken place. Vasa efferentia not observed. Vasa deferentia discernible along dorso-median borders of nerve cords in region along posterior part of pharyngeal chamber where they show enlargement and constitute "false seminal vesicles;" from level of mouth opening leading dorsally and medially to unite in base of penis papilla (Figs. 3, 4, 5). Ejaculatory duct short and without enlargement. Penis without bulb, degen-

erate, conical to cylindrical in shape; no more than 60 microns in length by 70 microns in diameter at base in fixed material (Fig. 7).[2]

Atrial organs.—Genital pore in midline between a third and half the distance from mouth opening to posterior end of body. Atrium elongate, separated from pharyngeal chamber by a thin partition; walls in some specimens ruffled; no diaphragm or fold separating male and female portions; lining of clavate cells, inner circular and outer longitudinal muscle strands outside of lining epithelium (Figs. 3, 4, 5, 8). Atrium when bearing egg capsule distended to occupy most of space in mid-region between dorsal and ventral body walls, encroaching anteriorly on pharyngeal chamber and extending posteriorly beyond genital pore (Fig. 6). Bursa without usual sacciform enlargement, extending greater or less distance toward ventral surface in partition separating atrium and pharyngeal chamber, sometimes with dorsal extension. Bursa stalk narrow, without vaginal enlargement (Figs. 3, 4, 5). Shell glands abundant in region surrounding atrial complex, more concentrated adjacent to atrial walls. Cement glands absent.

General histological features.—Gut with usual three trunks, lateral diverticula abundant, no cross anastamoses observed between posterior trunks. Pharynx single, with inner circular muscles in a zone distinct from the longitudinal muscles which lie external to them.[3] Mucus glands abundant near body surface, more numerous toward margins of body; when stained with Mallory's stain the blue-staining glands outnumber those staining pink or orange. Rhabdites and rhabdite forming cells apparently absent. Muscles of body wall in usual arrangement beneath basement membrane, transverse and vertical body muscles sparse except in head region. Parenchyma not as compact as in most planarians; this feature together with weakness of musculature possibly correlated with method of extrusion of egg capsules. Some histolysis during later part of life and following period of sexual reproduction.

Observations on Life History

Occurrence in nature.—The records of the collections I have made of *H. retenuova* are found in an accompanying table (Table 1) together with data on the length of life in the laboratory and the numbers of egg capsules deposited. All of the collecting stations mentioned are in the Town of Seekonk, Massachusetts, not far from the Rhode Island State Line. The most fruitful collections were from Station 1, a vernal pond with a leafy bottom, located along Woodard Avenue about a mile from the State Line. Station 2 is a vernal pond with a grassy bottom, located east of Prospect Street on the Wheeler

2 Such extreme degeneracy has certainly not been described for any of the American Paludicola although it has been for *Bdellocephala*, a European genus of the Dendrocoelidae, and has been observed to be common for some of the terrestrial triclads (von Graff, 1912-1917).

3 This characteristic in the absence of any of the special features of the family Kenkiidae erected by Hyman (1937a) places the species in the family Planariidae (Kenk, 1930).

School Farm, about a half mile north and west of Station 1. Station 3 is a spring-fed swampy stream, about 30 yards east of the State Line and some 200 yards north of the Taunton Pike. It is approximately two miles south of Stations 1 and 2. At Station 3, water is apparently present throughout the year since *Phagocata woodworthi*,[4] *P. velata*, and *Procotyla fluviatilis* were also found at this station. *P. velata* has also been collected from the vernal pond at Station 2.

TABLE 1.—Record of collections of *H. retenuova*, together with data on length of life in laboratory and egg capsule production.

Date	Collecting Station *	Number of Specimens	First Deaths	Last Deaths	Number of Capsules
1937					
April 1	1	10	April 20	April 20	....
April 15	1	15	April 20	April 20	....
April 24	1	15	.....	May 10	.... **
May 25	1	16	May 31	June 5	16
		56			40+
1938					
Dec. 1 ('37)	1	2	Jan. 10	May 9	3
Jan. 15 ***	1	..	.....	....	....
Feb. 26	1	25	March 4	May 8	27
March 9	1	12	April 18	May 1	6
March 23	3	9	April 15	May 4	5
March 23	1	15	April 25	May 8	4
April 1	1	31	April 23	May 10	18
April 1	2	2	.....	June 20	2
April 1	3	17	April 18	May 8	3
April 25	1	47	May 1	May 28	28
June 6	1	25	.....	June 22	6
		185			102

* Location of collecting stations given in text.
** Records incomplete for first three lots of worms.
*** Debris from the bottom of the pond was collected from beneath six inches of ice on this date and another date about two weeks later. No worms were recovered.

During the spring of 1937 a total of about 56 worms were collected. Some of these were fixed for histological study soon after their collection; others were retained in the laboratory until their deaths for periods up to 17 days after collection. The first two lots of worms were lost, perhaps by accident as has been related, soon after their collection. In the 1937-38 season about 180 worms were collected and observed. Some of these were fixed for study and others

4 This form was not identified properly by examination of the sexual apparatus. It was taken to be *P. woodworthi* rather than *P. gracilis* since Hyman (1937b) has indicated that the latter species does not occur east of he Hudson River.

died soon after their collection. In general all of the worms died within four to six weeks of the time of collection and few survived later than early June, at which time the vernal ponds at Stations 1 and 2 were almost dry.

Sexual reproduction.—During the seasons that specimens of *H. retenuova* have been cultured in the laboratory the formation of egg capsules has been observed many times. The larger specimens have often contained fully formed capsules when collected or have been observed to form them during their sojourn in the laboratory. In individuals isolated for observation the fully formed capsules were retained in the body for periods of time from ten to twenty-seven days before being deposited. Preceding the formation of the capsule a large mass of yolk could be seen in the living worm in the region of the atrium. Within from one to several days the yolk was surrounded by a yellowish shell which within the next day or more turned to a reddish brown. This color deepened considerably in the period that followed, but otherwise there was no further change. Egg capsules that had been extruded from the body had a "mahogany" color.

As an example of the reproductive history the laboratory record of a single worm will be cited. On December 16, 1937, two worms were isolated from debris which had been collected from the vernal pond at Station 1 on December 1. They were put together in a fingerbowl kept on a water table at about 17° C. At the time of isolation they measured about 6 and 10 mm. respectively in length. The larger worm was conspicuously mottled in appearance as a consequence of a heavy parasitic infection. The two worms were fed at intervals on beef liver and increased considerably in size. On January 10, 1938, the larger worm was found completely cytolyzed, presumably as a result of the parasitic infection. By February 11 the remaining worm had attained a length of between 10 and 12 mm. and was observed to be carrying a large egg capsule, dark in color. This capsule was deposited during the night preceding February 23, on which date a new mass of yolk was observed to have accumulated in the atrium. Two days later the yellowish shell of this second capsule was formed and by February 26 it was dark brown in color. This capsule was retained in the body until its deposit during the night of March 17-18. A small mass of yolk seen in the atrium on the subsequent day grew in size over a period of days but did not have a shell formed around it until March 27. This third capsule was carried until April 23 when it was deposited. Although the worm appeared in good condition at this time it had decreased from its maximum size and no further yolk was accumulated in the atrium. On May 8 whitish spots appeared to indicate the onset of cytolysis and the worm was found completely cytolyzed on May 9.

The particular specimen for which life history details have been given above was cultured for 144 days in the laboratory after its isolation. During the first four weeks it was kept in the same container with another worm and copulation may have taken place. Three egg capsules were formed in succession and these were carried for periods of at least 12, 23, and 27 days from the time they were fully formed until they were finally extruded from the body.

Although these capsules were kept isolated from others for some time they did not hatch and evidence concerning their fertility is lacking.

In general all of the larger worms collected have appeared to be sexually mature for many of them were bearing capsules at the time of their collection or formed them during the period of laboratory culture. On two separate occasions worms with forked "tails" were observed to be carrying two egg capsules, one in each of the forks of the posterior end of the body. One worm with a single atrium and posterior body region was observed carrying two capsules at the same time. One of these was dorsal to the other and possibly lying in the parenchyma dorsal to the atrium. The dorsal capsule was larger than the ventral one and when first seen was darker in color and so presumably had been formed first.[5]

Some histolysis appeared to take place during the latter part of the life of the worms. Worms fixed late in the spring in the weeks preceding the time when they might be expected to die showed a considerable breakdown of internal structures. There was often some decrease in body length during this period. It is possible that the body tissues may be converted into yolk and that the death which usually follows the period of sexual reproduction is a consequence of the depletion of body reserves. Death was often preceded by local histolysis, particularly in the region of the body posterior to the pharynx and atrium.

Extrusion of egg capsules.—I have never observed the actual extrusion of egg capsules that has been described by Chidester (1908). He has described in detail the rotation of the egg capsule in the atrium, followed by the apparent rupture of the atrial wall and the passage of the capsule through the parenchyma of the posterior end of the body to finally break through the body wall near the posterior end. I have observed worms with injured posterior ends and on one occasion observed a worm with the pharynx protruding through a rupture in the body wall in the region dorsal to the atrium. Either of these types of injury might have been caused by the extrusion of an egg capsule in the manner seen by Chidester. It seems to me unlikely that a second capsule would form immediately after the extrusion of a first if there had been extensive trauma of the atrium. It is possible that the egg capsules escape into the parenchyma a matter of days before they are finally extruded from the body. During the period of their retention in the parenchyma the atrial wall would then have opportunity for repair before the formation of the succeeding capsule. It seems safe to say that the extrusion of egg capsules through a region apart from the genital pore is if not universal then at least a common occurrence in this species.

5 The time of emergence and activity of the worms observed by Chidester as stated in his paper (Chidester, 1908) and amplified in a personal communication differs somewhat from that I have observed. About the middle of October worms bearing egg capsules were observed in one of his aquaria. About three weeks elapsed between the successive extrusion of three egg capsules although it was kept for a period of two months following the extrusion of the third capsule. The period of time covered is from about the middle of October until approximately the end of January.

Description of egg capsules.—The color of the mature egg capsules has already been described. In shape they generally have the appearance of a prolate spheroid. Measurements with an ocular micrometer were made upon a group of 38 eggs obtained during the spring of 1937. The average length observed was 1.22 mm. and the average greatest diameter was 0.73 mm. The average proportion of length to diameter was 1.66. The greatest L/D ratio observed was one of 2.05 in a capsule 1.54 by 0.75 mm., and the smallest ratio one of 1.31 in a capsule 0.71 by 0.54 mm. The longest capsule in the group had a length of 1.86 mm. and the shortest a length of 0.71 mm. The proportions of "average" capsules and of those having extreme L/D ratios are shown in Figure 2. It was usual in the longer and slenderer capsules to find the diameter near one end appreciably greater than that near the other end, with the result that the capsules were more oval in outline (Fig. 2c).

Hatching of egg capsules.—There seems no question but that the egg capsules of *H. retenuova* in their natural state in vernal ponds must remain dormant through the summer and early autumn when the ponds are dry and therefore are what have been called by other authors "winter" or "resting" egg capsules. Without question a considerable period of dormancy precedes their hatching and it may be that in nature some environmental stimulus is essential to induce the emergence of young worms from the capsules. The vernal pond from which most of my specimens were collected usually contains no water except for a few hours after a heavy rain during the period from about the middle of June until the middle of November or later. It is a typical "fairy shrimp" pond in all respects. In this location it seems probable that the egg capsules remain dormant from the time they are deposited in the late winter or spring until early winter when water is again present in the pond.

Attempts have been made to induce the hatching of capsules deposited in the laboratory but without success. Details of the experiments will not be here recorded since none of them led to a successful method. Alternate freezing and thawing did not induce the emergence of worms, nor did placing them in a refrigerator at temperatures a few degrees above freezing for periods up to several weeks. Drying caused the collapse of the capsules and the death of the contained young worms, as was determined by opening the capsules after returning them to water. Partial desiccation followed by a return of the capsules to water induced no hatching. Likewise no emergence of worms followed a transfer of capsules to distilled water or repeated transfers between distilled water and aquarium water carried out over a period of days or weeks. All of these experiments were carried out within the first two months after the capsules had been deposited.

Young worms do develop in the capsules although not so rapidly as in some other species of triclads. Capsules opened from six to eight weeks after they have been laid were observed to contain from two to four fully formed young worms. Intact capsules of this age or slightly younger when viewed under strong illumination with a dissecting microscope are sufficiently trans-

parent that the eyes of the contained young worms may be seen through the capsule wall. The worms were at times observed to be moving around within the capsules.

The hatching of capsules has been observed only under unusual and not well controlled circumstances. Capsules deposited during the spring of 1937 were kept during the early summer in a fingerbowl of aquarium water at room temperature in the laboratory at Providence. On July 31 they were placed in a pint jar half filled with the water in which they had been kept and were transported by car to Cold Spring Harbor, Long Island. At the end of the journey the jar containing the capsules was opened and placed on a laboratory table; the water was not changed. The next morning many of the capsules were observed to have broken open and small worms were crawling about the sides and bottom of the jar. Most of these worms were removed to a fingerbowl of spring water. By the next day all of the remaining capsules had hatched. Some of the worms cytolyzed soon after hatching and on August 3 the group of worms was separated into two lots of about 25 worms each and beef liver was placed in the containers. No worms were observed to feed and after an hour the liver was removed, the dishes were carefully cleaned of liver fragments, and the water renewed. One lot was placed on a water table at about 16° C. and the other in a refrigerator at about 8°. All worms in both dishes died within the next day.

The experience with the hatching of capsules from the 1938 collection was similar. By the end of July some 80 intact capsules remained from the unsuccessful hatching experiments. These were transported by car to Cold Spring Harbor and within two days after arrival about half of the capsules had hatched. No more worms emerged during the six weeks they were kept at Cold Spring Harbor. Shortly after September 10 the remaining capsules were carried by car to Ohio. Some of the capsules hatched during the journey and all of the remainder soon after arrival.[6]

Newly hatched specimens of *H. retenuova* were observed to be from 1.5 to 3 mm. in length, without pigment, and with rounded and nearly translucent heads. Those obtained during the summer of 1938, both at Cold Spring Harbor and in Ohio, were kept in spring water and fed on beef liver. Some lived for as long as three weeks, grew to a length of about 5 mm. and became grayish in color. I did not succeed in raising them beyond this point to maturity.

Summary of life history data.—H. retenuova has been observed to occur in vernal ponds and in a spring-fed swampy stream in southern Massachusetts. In the vernal pond locations worms have been collected throughout most of

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6 In April, 1940, 13 specimens were collected by Dr. A. M. Banta from the pond at Station 1 and sent to me at Chicago. Before their deaths in early June these worms deposited 11 egg capsules. In late August these capsules were transported to Columbia, Missouri. Young worms emerged from the capsules during October. In view of the lack of success in earlier attempts no effort was made to culture these worms further.

the period when water was in the ponds. The ponds were completely dry within two weeks of the date of the latest collections in early June. Worms collected from the ponds from the latter part of February on to the end of the season were often bearing egg capsules at the time of collection or formed them soon after being brought into the laboratory. A single specimen surviving from a December collection started to form its first egg capsule in the laboratory early in February and deposited three capsules in succession before its death in early May. From these data, the collection records, and the information concerning the dormancy of egg capsules it is possible to reconstruct the probable life history in a fairly satisfactory manner.

Egg capsules deposited during the winter and spring must lie dormant through the summer and autumn while there is no water in the ponds, some retained moisture in the leaf mold and debris in the pond bottoms being possibly necessary for their preservation. The young worms emerge in the late autumn or early winter when there is again water in the ponds. They mature rapidly and must be markedly protandrous since functioning testes have disappeared although mature sperm are present in the genital tracts of worms collected during the winter. During the late winter and early spring they are sexually mature and produce egg capsules. The worms die after depositing one or more egg capsules or with the advent of summer and the drying of the ponds. The egg capsules persisting through the summer provide for the generation of worms that appears in the ponds the following season.

There is some evidence that the life span of individual worms may be limited by internal factors apart from the circumstances of the natural conditions in the pond. It was my experience and also that of Chidester (1908) that worms died after depositing one or more capsules and could not be maintained indefinitely in the laboratory. All worms brought into the laboratory died by the time those in nature must have succumbed as a consequence of the drying of the ponds.

It is possible that the species may lead a year around existence in the spring-fed swamp at collecting Station 3, but it was not possible to continue collections there throughout the year. The presence there of species of triclads which can not endure the desiccation of a vernal pond testifies that water must be available throughout the year. The life history in this situation may be different from that outlined above.

There exists a remarkable similarity between the life history of *H. retenuova* in a vernal pond and that of *Phagocata velata* in similar circumstances (Castle, 1927). In the case of *P. velata* over-summering is accomplished by the fragmentation of the body and the enclosure of the fragments in cysts which can withstand the drying of summer. In the case of *H. retenuova* the egg capsules are the over-summer stage of the life history. *P. velata* has never been observed to become sexually mature under these conditions of existence, although it may in spring-fed streams.

Genus **Hymanella** n. gen.

Definition.—Planariidae with two eyes, poorly developed auricles, and head of low triangular form; testes apparently prepharyngeal; penis without bulb, penis papilla greatly reduced; seminal vesicles absent; no adenodactyl; common oviduct opening into anterior face of bursa stalk or into roof of common atrium; male atrium very elongate; bursa copulatrix elongate; tubular, without usual sacciform enlargement; egg capsule a prolate spheroid, retained in the atrium some time before extrusion, not stalked. Type and only known species, *H. retenuova*, n. sp. Type locality: vernal ponds and a spring-fed swampy stream in Seekonk, Massachusetts. Collected also by Chidester (1908) from a small pond in Worcester, Mass.[7]

Differential diagnosis.—Related in structure to *Curtisia* and *Phagocata*. Body form and head shape intermediate between the two; *Curtisia* shorter and more chunky with more strongly developed auricles; *Phagocata* with slenderer body and more narrow truncate head. Common oviduct entering the anterior face of bursa stalk or extreme posterior end of atrium; in *Phagocata* entering the roof of the atrium and in *Curtisia* the posterior face of the bursa stalk. Degenerate penis found in no other American genus. Bursa in shape similar to that of *Curtisia;* slenderer than in *Phagocata*.

H. retenuova

Length up to 15 mm., uniformly dark grayish in color; markedly protandrous; occurring usually in vernal ponds during the winter and spring; egg capsules remaining dormant through the summer and giving rise to a new generation the following season.

Differential diagnosis.—Comparable only to some species of the genera *Curtisia* and *Phagocata*. In life history similar to *P. velata;* in *P. velata* encysted fragments the resistant over-summering stage while in *H. retenuova* egg capsules fill this rôle. Retention of egg capsules in the body unique for *H. retenuova*. Capsules less spherical than in species of *Curtisia* or *Phagocata;* like those of *P. velata* in absence of stalk.

Holotype.—Catalog No. 20574, U. S. National Museum.

Paratype.—Catalog No. 20575, U. S. National Museum.

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7 Chidester's paper does not include the collection data on the worms he observed. More exact information would be of interest since his was the first recorded observation of this species. A recent private communication from Dr. Chidester informs me that the material from which he isolated specimens was collected from "a small pond near the Clark University campus in Worcester, Mass."

Summary

1. The genus Hymanella of Planariidae is defined.

2. One species, *H. retenuova*, with the characters of the genus is described from vernal ponds and a spring-fed swampy stream in Seekonk, Massachusetts.

3. In vernal ponds *H. retenuova* is present through the winter and spring and deposits egg capsules which remain dormant through the summer when the ponds are dry.

4. The egg capsules resist experimental attempts to induce hatching and demand a resting period of several months before the young worms will emerge.

5. Specimens collected from nature appear to have a limited life span which is terminated after egg capsules are deposited.

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LEGENDS FOR FIGURES

Fig. 1. *H. retenuova*, drawn from a living specimen, showing the general shape and proportions of the body, shape of the head, and positions of the eyes, mouth opening, and pharyngeal chamber.

Fig. 2. Shapes of the egg capsules of *H. retenuova*. a. The "roundest" observed, L/D ratio 1.31. b. The "average" shape observed, L/D ratio 1.66. c. Most elongate shape observed, L/D ratio 2.05. The tapering form shown is characteristic of the more elongate capsules.

Fig. 3. A semi-diagrammatic lateral view of the atrial complex of *H. retenuova*. The usual development of the bursa copulatrix and entrance of the common oviduct into the anterior side of the bursa stalk are shown.

Fig. 4. A semi-diagrammatic lateral view of the atrial complex of *H. retenuova*. This is a composite figure to show the extreme observed development of the bursa copulatrix and the entrance of the common oviduct at a point more ventral than that usually observed. Parts are as indicated in Fig. 3.

Fig. 5. A semi-diagrammatic dorsal view of the atrial complex of *H. retenuova*.

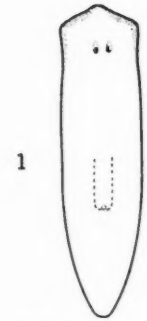
Fig. 6. A semi-diagrammatic sagittal section of a specimen of *H. retenuova* bearing an egg capsule to show the distension of the atrium and the displacement of other organs.

Fig. 7. Detail of a sagittal section through the penis of *H. retenuova*. Note the small form and lack of differentiation of the penis and penis bulb and the transition of the typical clavate cells of the atrial lining to the flattened cells of the epithelium over the penis. Sperm are to be seen in the vasa deferens and ejaculatory duct. The opening of the ejaculatory duct at the tip of the penis papilla appears in a section lateral to the one chosen.

Fig. 8. Detail of the region adjacent to the point of entrance of the common oviduct into the bursa stalk. The section is tangential to the posterior part of the atrium and shows the muscle fibers of the atrial wall. The actual point of opening of the common oviduct is seen at about the point marked "x" in an adjacent section. The section chosen for illustration shows more of the course of the bursa stalk and common oviduct than does the section passing through the junction of the two tubes.

Orientation: Figs. 3, 4, 6, 7, and 8 — dorsal surface of the worm uppermost, anterior end to the left. Fig. 5, anterior end uppermost.

For all figures: *a*, atrium; *b*, bursa copulatrix; *bs*, bursa stalk; *co*, common oviduct; *ec*, egg capsule; *ed*, ejaculatory duct; *gp*, genital pore; *m*, muscle fibers; *mo*, mouth opening; *o*, oviduct; *p*, penis; *pc*, pharyngeal chamber; *ph*, pharynx; *s*, sperm; *vd*, vas deferens.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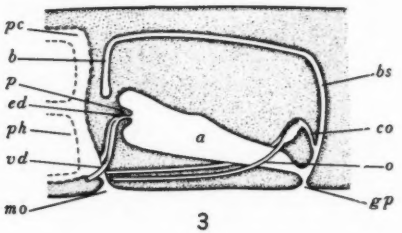
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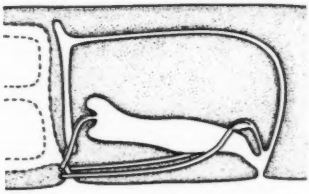
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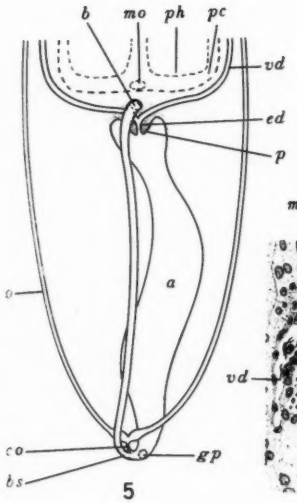
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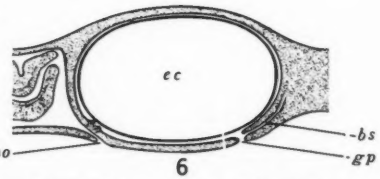
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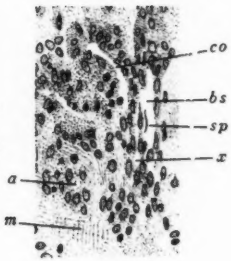
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Studies on Monogenetic Trematodes

V. Tetraonchinae of the Stump-Knocker Sunfish, Eupomotis microlophus (Guenther)*

John D. Mizelle

Only one previous paper (Mizelle 1941) has dealt with gill parasites from the stump-knocker sunfish. In it was described a new species, *Anchoradiscus anchoradiscus*, for which the genus indicated was proposed for its reception. The present paper completes the work on available material, from the above host, which was collected from Florida and kindly placed at the author's disposal by Dr. R. V. Bangham of the College of Wooster, Wooster, Ohio.

A total of five species has been found to infest the stump-knocker. Two of them, namely, *Cleidodiscus nematocirrus* and *Actinocleidus maculatus* were previously described by Mueller in 1937. Available specimens of these have prompted the author to add more information concerning them in the nature of redescriptions. For comparative purposes the measurements available in the original descriptions have been supplied in quotations for the convenience of individuals interested in this group of parasites.

Cleidodiscus nematocirrus Mueller, 1937

Figs. 1-16

Host and Localities: Stump-Knocker Sunfish, *Eupomotis microlophus*, (Günther), Englewood Pond, Englewood, Fla.; Everglades Canal, Naples, Fla.; and Lake Okeechobee, Moore Haven, Fla.

Previously Reported Host and Locality: Pumpkin-Seed Sunfish, *Eupomotis gibbosus* (Linnaeus), Fla.

Site of Infestation: Gills.

Number of Specimens used in this Investigation: Five.

Redescription: Moderately large dactylogyrids with a thin smooth cuticula. Average length 1.116 mm. (0.720-1.620 mm.) "0.555 mm. long," greatest body width 0.193 mm. (0.159-0.219 mm.) "0.185 mm. wide." Peduncle long and gradually attenuated to unite with the somewhat knob-shaped haptor which contains four comparatively large irregularly shaped structures of an apparent granular nature; haptoral width 0.112 mm. (0.090-0.149 mm.), length 0.069 mm. (0.054-0.079 mm.). Haptoral bars dissimilar and variable in shape. Ventral bar generally with ends bent under (Figs. 12-14), length 0.028 mm.; dorsal bar usually with slightly knobbed ends (Figs. 11, 15) and 0.026 mm. (0.024-0.028 mm.) in length. "Bars non-articulate, subequal, about 0.025 mm. long." Anchors inconstant in shape and often with a chitinous

* Contribution from the Department of Biology, University of Notre Dame, Notre Dame, Indiana.

structure adherent to the tip of each superficial anchor root; deep roots vestigial or wanting. Anchor shafts and points regularly recurved and hollow; each shaft often with an elevation near its junction with the base (Figs. 3, 7). Length of ventral anchors 0.030 mm. (0.028-0.032 mm.), width 0.018 mm. (0.015-0.022 mm.); length of dorsal anchors 0.029 mm. (0.027-0.030 mm.), width 0.018 mm. (0.015-0.022 mm.). "Anchors equal, 0.029 mm. in greatest dimension, with hollow shafts." Hooks fourteen in number, arrangement normal for the genus, solid, and each (except members of pair number one) with a comparatively large base which tapers to unite with the opposable piece and sickle-shaped termination. Hooks of pair number one with a solid oval base and a slender solid shaft. The nature of the hooks of pair number five could not be ascertained with certainty but they lie between the anchors as determined in the original description (Mueller 1937). A posteriorly projecting structure is present on the sickle-shaped termination of each hook. Hook lengths 0.011-0.022 mm. Members of pair number one shorter than the rest of the hooks which are of relatively uniform length in a given specimen. "Hooks 0.021 mm. long—." Posterior eye spots larger and farther apart than members of the anterior pair. Pharynx ovate, longitudinally elongate, transverse diameter 0.061 mm. (0.046-0.070 mm.), "about 0.053 mm. in diameter." Gonads ovate (longitudinally elongate) in outline and situated in the anterior body half. Ovary larger than, less elongate than, and lies anterior or anteroventral to, the testis. Vagina sinistral and located in the anterior body half. Copulatory complex well developed and consisting of an accessory piece and a cirrus. Accessory piece solid, base bifurcate and articulated to cirrus base, distal portion doubly curved, and with a structure which passes from ventral to dorsal side to produce a knob in the anterior half (Figs. 2, 8, 9); length 0.050 mm. (0.046-0.054 mm.). Cirrus with a large base and an extremely long attenuated portion; length about four or five times that of the accessory piece. "Accessory piece about 0.044 mm. long; cirrus, following the curves, at least 0.26 mm. long."

Six of the eight measurements given in the original description of this species (Mueller 1937) agree very well with corresponding measurements obtained in this work. The accessory piece length in the former is only slightly less than the minimum found herein but the body length is 0.165 mm. less than the minimum and less than one-half the average length given in the redescription. Both hosts are from the same ecological region. A suggested reason for this discrepancy is that possibly *Eupomotis microlophus* is better adapted as a host for this species, than is *E. gibbosus*.

Urocleidus attenuatus n. sp.

Figs. 25-38

Host and Localities: Stump-Knocker Sunfish, *Eupomotis microlophus* (Günther), Englewood Pond, Englewood, Fla.; Everglades Canal, Naples, Fla.; and Lake Okeechobee, Moore Haven, Fla.

Site of Infestation: Gills.

Number of Specimens used in this Investigation: Nine.

Type Specimens: Cotypes, U. S. National Museum, Washington, D. C.

Description: Moderately large dactylogyrids with a smooth cuticula. Average length 0.765 mm. (0.392-1.350 mm.), greatest body width 0.146 mm. (0.108-0.172 mm.). Peduncle short to extremely long (depending on the state of contraction at fixation) and at times very broad. Haptor subquadrate with the posterior end truncate to slightly rounded; width 0.132 mm. (0.095-0.151 mm.), length 0.072 mm. (0.065-0.083 mm.). Haptoral bars dissimilar and variable in shape. Ventral bar with rounded ends and generally with a pair of prongs or an elevation near the midlength (Figs. 33, 34). Dorsal bar usually with knobbed ends and often bent in the midportion (Figs. 35, 36). Attachment of bars to anchors is made to the mesiolateral surfaces. Ventral bar length 0.027 mm. (0.024-0.028 mm.), dorsal bar length 0.030 mm. (0.026-0.032 mm.). Anchors broad, flat, similar in shape, and with regularly recurved solid shafts and points; ventrals larger. Anchor bases slightly bifurcate, deep roots often folded to one side (Figs. 30, 32). Length of ventral anchors 0.032 mm. (0.026-0.035 mm.), width of bases 0.019 mm. (0.016-0.024 mm.). Length of dorsal anchors 0.028 mm. (0.025-0.030 mm.), width of bases 0.016 mm. (0.013-0.021 mm.). Hooks fourteen in number and with little variation in length (except for members of pair number five) in a given specimen. Each hook, except those of pair number five, composed of an elongate hollow base, a short solid shaft, a sickle-shaped termination, and a small opposable piece (Fig. 37). Hooks of pair number five differ from the others in the possession of a shorter length, a small solid oval base, and a slender solid shaft (Fig. 38). Hook lengths 0.013-0.028 mm. Eye spots four, ovate, and with the long axes directed diagonally to the midline of the body. Members of the posterior pair larger and farther apart or closer together than members of the anterior pair. Cephalic lobes moderately developed. Openings of the head organs not extending posterior to the cephalic lobes. Pharynx ovate, longitudinally elongate, and often with the long axis rotated from the normal position. Gonads elongate in longitudinal outline and situated near the midportion of the body. Ovary larger than, and located anterior to the often extremely elongate testis. Vagina conspicuous, dextral, and situated in the posterior part of the anterior body half. Copulatory complex consisting of a corkscrew-like cirrus and an accessory piece. Cirrus often spined at junction of base and shaft; length 0.091 mm. (0.081-0.096 mm.). Accessory piece a very thin sleeve-like structure which at times appears to lie to one side of the cirrus and at other times to enclose it (Figs. 25, 26). Cirrus and accessory piece nonarticulate with each other. Vitellaria moderately developed and terminate on the peduncle.

The cirrus in this species remotely resembles that of *Urocleidus ferox* Mueller, 1934, but differs from it *(U. ferox)* in the possession of an accessory piece and a heavy type of anchor as found in *Cleidodiscus capax* Mizelle, 1936.

ACTINOCLEIDUS MACULATUS Mueller, 1937
Figs. 17-24

Host and Localities: Stump-Knocker Sunfish, *Eupomotis microlophus* (Günther), Myakka River, State Park, East Sarasota, Fla., and Everglades Canal, Naples, Fla.

Previously Reported Host and Locality: Pumpkin-Seed Sunfish, *Eupomotis gibbosus* (Linnaeus), Fla.

Site of Infestation: Gills.

Number of Specimens used in this Investigation: Four.

Redescription: Small dactylogyrids with a thin smooth cuticula. Head region generally much narrower than the adjacent body region. Average body length 0.457 mm. (0.370 0.563 mm.), greatest body width 0.097 mm. (0.063-0.123 mm.). Peduncle moderate to very short, depending on the state of contraction during fixation. Haptor discoidal with both pairs of anchors situated ventrally; haptoral length 0.067 mm. (0.065-0.070 mm.), width 0.077 mm. (0.070-0.082 mm.). Haptoral bars dissimilar in shape. Anterior bar bent posteriorly in the midportion and articulated to the posterior bar which is plate-like and has large "shoulders" (Figs. 17, 18). Length of anterior bar 0.046 mm. (0.043-0.048 mm.), posterior bar length 0.030 mm. (0.029-0.031 mm.). Anchors constant in shape, regularly recurved, and with hollow terminal shafts and points. Anterior anchor bases infrequently bifurcate and generally with poorly developed deep roots. Deep roots of posterior anchors vestigial or wanting. Anterior anchor length 0.041 mm. (0.037—0.046 mm.), width of base 0.012 mm. (0.011-0.013 mm.); posterior anchor length 0.041 mm. (0.038-0.044 mm.), width of base 0.011 mm. (0.010-0.012 mm.). "Anchors equal, 0.039 mm. in greatest dimension—." Hooks fourteen in number and uniform in shape (Fig. 20). Each consists of a subspherical base, a relatively long solid slender shaft, a sickle-shaped termination, and an opposable piece; hook lengths 0.013-0.018 mm. Eye spots four in number. Members of the posterior pair larger than those of the anterior pair, ovate in shape, and each with the long axis directed obliquely to the body axis. Anterior eye spots roughly subspherical in shape and situated farther apart than members of the posterior pair. Head organs numerous and arranged around the sides of the head as far posteriorly as the level of the anterior eye spots. Pharynx circular in outline, transverse diameter 0.020 mm. (0.017-0.024 mm.). Gonads situated in anterior portion of posterior body half, approximately the same size, and roughly ovate in shape with their long axes directed longitudinally. Testis posterior to ovary and with the anterior surface pressed against the posterior side of the latter. Vagina sinistral and near the body midlength. Copulatory complex consisting of a sigmoid cirrus with a large base, and a curved solid accessory piece which articulates with the cirrus. Cirrus length 0.049 mm. (0.043-0.053 mm.), "greatest straight dimension 0.053 mm."; accessory piece length 0.033 mm (0.031-0.037 mm.), "greatest dimension 0.035 mm." Vitellaria moderately developed and terminate on the peduncle.

Only three measurements were available for this species in the original description (Mueller 1937). Although they differ slightly from the averages obtained for the same structures in this work, none of them are beyond the extremes reported herein. Apparently, in the same habitat, the two hosts reported for this parasite are equally suitable.

Actinocleidus bifurcatus n. sp.
Figs. 39-47

Host and Localities: Stump-Knocker Sunfish, *Lepomis microlophus* (Günther), Everglades Canal, Naples, Fla., and Lake Okeechobee, Moore Haven, Fla.

Site of Infestation: Gills.

Number of Specimens used in this Investigation: Three.

Type Specimens: Cotypes, U. S. National Museum, Washington, D. C.

Description: Moderately small dactylogyrids with a smooth cuticula which attains a thickness of 0.003 mm. in some areas. Average length 0.701 mm.

EXPLANATION OF PLATE

All figures were drawn at the same magnification with the aid of a camera lucida.

Cleidodiscus nematocirrus Mueller, 1937

Fig. 1, Cirrus
Figs. 2, 8, 9, Accessory pieces
Figs. 3, 5, 7, Ventral anchors
Figs. 4, 6, Dorsal anchors
Figs. 11, 15, Dorsal bars
Figs. 12-14, Ventral bars
Fig. 16, Hook

Actinocleidus maculatus Mueller, 1937

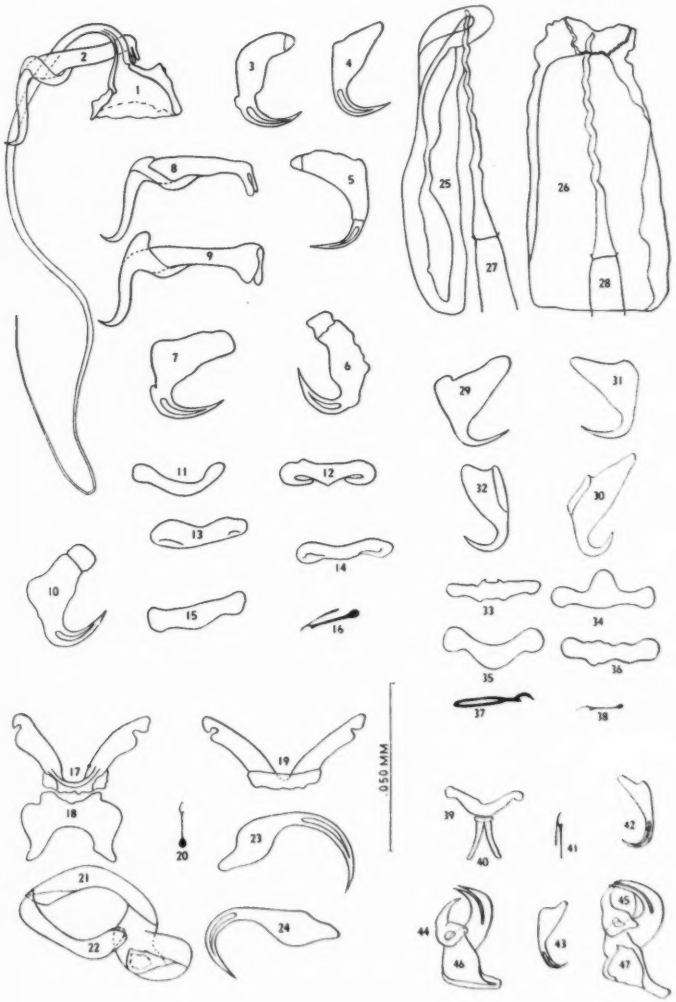
Figs. 17, 19, Anterior bars
Fig. 18, Posterior bar
Fig. 20, Hook
Fig. 21, Cirrus
Fig. 22, Accessory piece
Fig. 23, Anterior anchor
Fig. 24, Posterior anchor

Urocleidus attenuatus n. sp.

Figs. 25, 26, Accessory pieces
Figs. 27, 28, Cirri
Figs. 29, 30, Ventral anchors
Figs. 31, 32, Dorsal anchors
Figs. 33, 34, Ventral bars
Figs. 35, 36, Dorsal bars
Fig. 37, Ordinary hook
Fig. 38, Hook or pair No. 5

Actinocleidus bifurcatus n. sp.

Fig. 39, Anterior bar
Fig. 40, Posterior bar
Fig. 41, Hook.
Fig. 42, Anterior anchor
Fig. 43, Posterior anchor
Figs. 44, 45, Accessory pieces
Figs. 46, 47, Cirri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(0.348-0.900 mm.), greatest body width 0.164 mm. (0.111-0.215 mm.). Peduncle moderate to short and flared terminally to produce an atypical haptor (for the genus) which superficially resembles that of *A. bursatus* (Mueller, 1936). Haptoral width 0.143 mm. (0.100-0.178 mm.), length 0.072 mm. (0.057-0.100 mm.). Anterior bar bent posteriorly in the midportion: posterior bar consisting of two posteriorly projecting arms which unite basally and articulate with the posterior surface of the bent portion of the anterior bar. Anterior bar length 0.021 mm. (0.019-0.022 mm.), posterior bar length (in reality the distance between the arm tips) 0.012 mm. Anchors generally similar in shape; shafts and points hollow and regularly recurved, bases usually slightly bifurcate. Anterior anchor length 0.023 mm. (0.022-0.024 mm.), width 0.007 mm.; posterior anchor length 0.019 mm. (0.014-0.023 mm.), width 0.009 (0.008-0.011 mm.). Hooks fourteen in number. Each consists of a small oval base, a slender shaft, a sickle-shaped termination, an opposable piece, and a posteriorly projecting structure arising from the convex surface of the sickle-shaped termination (Fig. 41). Hook lengths 0.013-0.016 mm. Eye spots four in number, irregularly circular to ovate in outline and with members of the posterior pair much larger and generally closer together than those of the anterior pair. Pharynx circular to ovate (longitudinally elongate) in outline and 0.047 mm. (0.032-0.065 mm.) in transverse diameter. Gonads situated near the body midlength and tending to occupy the first portion of the posterior body half. Ovary anterior to testis and ovate (longitudinally elongate) in outline. Testis obscured by the vitellaria. Vagina located on the left body margin. Copulatory complex consisting of a cirrus and an accessory piece which are basally articulate. Cirrus sigmoid and possessing a bifurcate termination; length 0.031 mm. (0.030-0.032 mm.); accessory piece claw-like and 0.018 mm. (0.016-0.020 mm.) in length. Vitellaria dense.

This species is very different from other members of the genus *Actinocleidus* Mueller, 1937. The sigmoid cirrus is remotely similar to that of *A. articularis* (Mizelle, 1936) and *A. maculatus* Mueller, 1937. The cirrus, in neither of these relatives of *A. bifurcatus*, is bifurcate. The accessory piece of this species is distinctive.

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Studies on Monogenetic Trematodes

VI. Two New Dactylogyrid Genera from Florida Fishes *

John D. Mizelle and Valentin Blatz

The genus *Anchylodiscus* was proposed by Johnston and Tiegs (1922) to receive *A. tandani*, the type species, from the gills of *Tandanus tandanus*. The only other species *(A. gadopsis)* of this genus was described by Hughes (1928) from the gills of *Gadopsis* sp. Both of these parasites are from Australian hosts. A careful examination of a species of *Tetraonchinae* from the gills of the robalo *(Centropomus undecimalis)* from Florida waters, reveals characters sufficient to place it in a genus distinct from its two nearest morphological relatives listed above. *Anchylodiscus* species are devoid of body spines and possess relatively short cuticular bars which are individual whereas the species from *C. undecimalis* has body spines which take origin as far forward as the copulatory complex and in addition possesses two very long bars (the longest being over twice as long as the longest anchor) which are articulated with each other in their midregions. It appears that this combination of characters together with host-parasite relationships are sufficient for generic distinction.

An exclusvely fresh-water genus, *Actinocleidus* Mueller, 1937, of Tetraonchinae also possesses articulated cuticular bars. In this group, however, the bars are much modified, both pairs of anchors occur on the same side of the haptor, and the intestinal crura are confluent with each other on or near the peduncle.

Rhadbdosynochus n. g.

Diagnosis.—Tetraonchinae with two haptoral bars which are fused with each other in their midportions, Anchors dissimilar. Hooks fourteen; each composed of a slender shaft, a sickle-shaped termination, and an opposable piece. Gut bifurcate with nonconfluent crura. Copulatory complex composed of a cirrus and an accessory piece which are basally articulate with each other. Vagina absent. Eye spots four in number. Parasitic on the gills of marine fishes.

Type species.—*Rhabdosynochus rhabdosynochus* n. sp.

Rhabdosynochus rhabdosynochus n. sp.

Figs. 1-10.

Host and locality.—Robalo, *Centropomus undecimalis* (Bloch), Myakka River, State Park, East Sarasota, Florida.

Number of specimens studied.—Ten.

* Contribution from the Department of Biology, University of Notre Dame, Notre Dame, Indiana.

Type specimens.—Cotypes, U. S. Nat. Mus., Washington, D. C.

Description.—Relatively small dactylogyrid trematodes with a very thin cuticula and with body spines which may take origin as far forward as the copulatory complex. Body length 0.452 mm. (0.290-0.622 mm.), greatest body width 0.120 mm. (0.094-0.152 mm.). Eye spots four in number, irregularly ovate in outline; members of the anterior pair smaller and farther apart than those of the posterior pair. Pharynx ovate, transverse diameter 0.031 mm. (0.024-0.036 mm.). Intestine bifurcate with two crura which terminate individually near the origin of the haptor. Haptor short, with the cuticular bars on the posterior margin, much wider than greatest body width, and very broadly united with the body. Length of haptor 0.069 mm. (0.054-0.094 mm.), greatest width 0.228 mm. (0.169-0.259 mm.). Haptoral bars two, dissimilar in nature, articulated to each other in their midportions, often with obtuse elevations apparently arising from their surfaces, and almost as long as the width of the haptor. Dorsal bar solid, ends rounded, often with terminal knobs, and 0.200 mm. (0.145-0.229 mm.) in length. Ventral bar possessing a lengthwise cavity, with pointed extremities, and somewhat shorter than the dorsal bar. Anchors dissimilar in size and shape and possessing regularly recurved solid shafts and points. Ventral anchor shafts slightly bent superficially; ventral anchor bases with well-differentiated roots; deep root hollowed out and very long, superficial roots short, solid, and each with a small projection at its base. This projection may be interpreted as an accessory superficial root. Ventral anchor length 0.072 mm. (0.067-0.076 mm.), width of base 0.021 mm. (0.017-0.024 mm.). Dorsal anchors with relatively straight shafts, moderately developed deep roots, superficial roots vestigial or absent. Dorsal anchor length 0.064 mm. (0.057-0.067 mm.), width of base 0.013 mm. (0.010-0.015 mm.). Hooks fourteen in number and arranged as in members of the genus *Cleidodiscus* Mueller, 1934, except that hooks of pair number one are shifted somewhat posterolaterally and those of pair number five have become more dorsolateral. Each hook consists of a slender shaft, a sickle-shaped termination, and an opposable piece; hook lengths 0.008-0.011 mm. Gonads situated near the body mid-length; ovary ovate, about one-half as large as, and located beneath, the irregularly ovate testis. Vagina absent. Copulatory complex comprised of a cirrus and an accessory piece. Cirrus a long tube which often appears bifurcate terminally. Accessory piece bent on itself and with the two ends articulate with each other at the cirrus base. Prostates two in number, seminal receptacle large. Vitellarial follicles numerous, crowded, and extending to the haptor.

Neodiplectanum n. g.

Diagnosis.—Diplectaninae with two haptoral bars which are articulated with each other in their midportions. Anchors similar in size and shape. Each hook composed of a slender sold shaft, a sickle-shaped termination, and an opposable piece. Copulatory complex comprised of a cirrus and an accessory piece which are basally articulate with each other. Vagina present. Eye spots four in number. Parasitic on the gills of marine fishes.

Type species.—*Neodiplectanum wenningeri* n. sp.

The newly proposed genus *Neodiplectanum* differs from *Diplectanum* Diesing, 1858, its closest relative, by the presence of two, instead of three, cuticular bars on the haptor. These two bars are apparently immovably articulated (fused) with each other in their midportions. This condition is similar to that found in the species of *Actinocleidus* Mueller, 1937, and *Rhabdosynochus*, a new genus described above. The squamodiscs are of the type found in *Diplectanum* and are composed of twenty-five to thirty rows of cuticular structures very similar to those figured for *Diplectanum collinsi* (Mueller, 1936). The body spines which are described for so many of the species of *Diplectanum* are absent in the species for which the new genus is proposed. The gut in *Diplectanum* species is bifurcate with nonconfluent crura, whereas the gut in *Neodiplectanum wenningeri* is apparently rhabdocoelate in nature. The latter statement cannot be made without some element of doubt because the vitellaria prevent unhampered observation of the digestive tract. Confirmation or correction must be made from fresh material or sections.

Neodiplectanum wenningeri* n. sp.

Figs. 11-21

Host and locality.—Silver Jenny, *Eucinostomus gula* (Cuvier and Valenciennes), Everglades Canal, north of Everglades City, Florida.

Number of specimens studied.—Nine.

Type specimens.—Cotypes, U. S. Nat. Mus., Washington, D. C.

Description.—Moderately small dactylogyrid trematodes with a very thin cuticula, body spines absent. Length 0.658 mm. (0.512-0.774 mm.), greatest body width 0.116 mm. (0.074-0.128 mm.). Eye spots four in number and roughly ovate in outline. Members of the anterior pair smaller and farther apart than those of the posterior pair. Cephalic lobes small. Pharynx circular to ovate in outline and 0.043 mm. (0.036-0.051 mm.) in transverse diameter. The nature of the intestine could not be definitely determined due to the heavy development of the vitellaria. It is apparently rhabocoelate in nature and terminates at the base of the peduncle immediately posterior to the vitellaria. Haptor disc-like, with squamodiscs composed of twenty-five to thirty concentric rows of cuticular structures, and connected to the body by a short peduncle. Cuticular structures very similar to those figured for *Diplectanum collinsi* (Mueller, 1936) but occupying a much greater proportion of the haptor than shown for this species. Length of haptor 0.139 mm. (0.104-0.169 mm.), greatest width 0.165 mm. (0.138-0.195 mm.). Haptoral bars two, subequal in length, dissimilar in nature, bent posteriorly in the middle, and articulated with each other in the midregions. Dorsal bar solid with rounded to knobbed terminations; ventral bar hollow with blunt to pointed ends. Greatest bar length 0.152 mm. (0.125-0.185 mm.). The cavernous ventral bar is generally longer than the dorsal bar, but in some specimens the dorsal bar was found to be

* This species is dedicated to the memory of the late Rev. F. J. Wenninger, C.S.C., Professor of zoology and parasitology in the University of Notre Dame.

longer. Anchors slender, similar in shape, with markedly bifurcate bases; ventrals slightly longer. Deep roots of bases extremely long, shafts and points solid and regularly recurved. Length of dorsal anchors 0.038 mm. (0.036-0.040 mm.), width of base 0.009 mm. (0.007-0.010 mm.); length of ventral anchors 0.042 mm. (0.036-0.045 mm.), width of base 0.007-0.009 mm.

Only six pairs of hooks were observed. Each consists of a slender solid shaft, a sickle-shaped termination, and an opposable piece; hook length 0.011 mm. (0.008-0.013 mm.). Their arrangement is similar to that shown for *Diplectanum collinsi* (Mueller, 1936). Gonads located near the middle of the body, subequal in size; testis circular to ovate in outline and situated posterior to, and often dorsally overlapping the ovate, longitudinally elongate ovary. Vagina sinistral and located in the posterior part of the anterior body half. Copulatory complex composed of a simple, gently curved, chitinous tube and an accessory piece with a slightly enlarged tip. Seminal vesicle and prostates not observed. Vitellaria numerous, crowded, and extend into the proximal portion of the peduncle.

ACKNOWLEDGEMENTS

The authors are grateful to Dr. R. V. Bangham of the College of Wooster, Wooster, Ohio, who collected and kindly placed the trematodes treated here, at the senior author's disposal; to Dr. H. J. Van Cleave of the University of Illinois, Urbana, Illinois, for checking the validity of the new generic names; to Mr. Bruno Limbach of the Illinois State Natural History Survey, Urbana, Illinois, for checking the nomenclature of the host names; and to Mr. Aaron Seamster of the Conners State Agricultural College, Warner, Oklahoma, for mounting the specimens.

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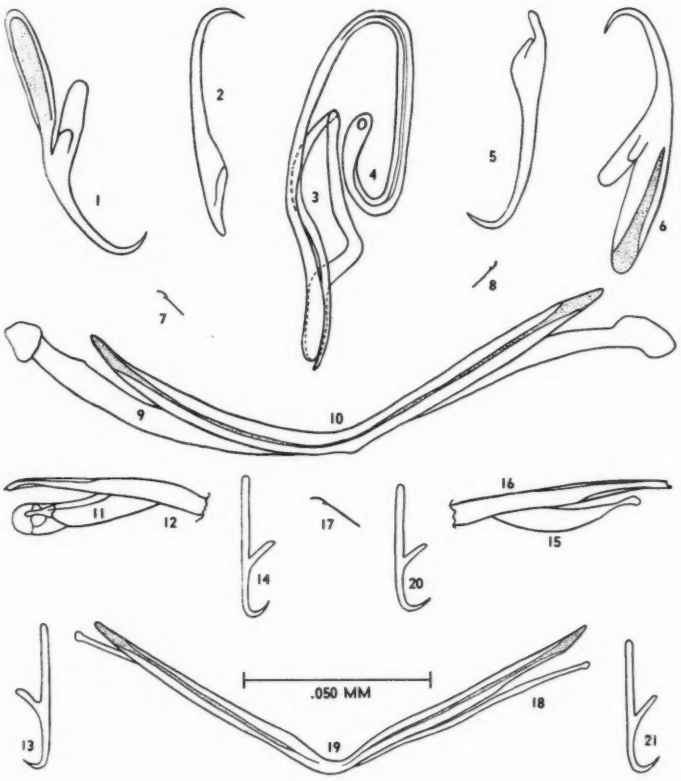

All figures were drawn at the same magnification with the aid of a camera lucida.

Figs. 1-10. *Rhabdosynochus rhabdosynochus* n. sp. 1 and 6. Ventral anchors. 2 and 5. Dorsal anchors. 3. Accessory piece. 4. Cirrus. 7 and 8. Hooks. 9. Dorsal bar. 10. Ventral bar.

Figs. 11-21. *Neodiplectanum wenningeri* n. sp. 11 and 15. Accessory pieces. 12 and 16. Cirri. 13 and 14. Ventral anchors. 17. Hook. 18. Dorsal bar. 19. Ventral bar. 20 and 21. Dorsal anchors.

Three New Florida Crayfishes of the Subgenus Cambarus[1]

(Decapoda, Astacidae)

Horton H. Hobbs, Jr.

Five species of the subgenus *Cambarus* are now known to occur in Florida. Of these, *Cambarus latimanus* and *Cambarus diogenes* subsp.? have previously been described, and have been recorded from numerous localities in other states. The remaining three species are described in this paper.

All of the Florida representatives of this subgenus are restricted to the panhandle, and even in this part of the state specimens have been taken from few localities.

Cambarus (Cambarus) cryptodytes sp. nov.

(Figs. 2, 3, 7, 11, 13, 15, 18, 21, 24, 28, 29)

Diagnosis.—*Cambarus cryptodytes* is a subterranean species; the eyes and carapace are without pigment, and no lateral spines are present on the rostrum. The first pleopod of the first form male is also distinct (Figs. 2 and 3).

Holotypic Male, Form I.—Body subcylindrical, slightly compressed dorso-ventrally. Abdomen slightly narrower than thorax.

Width of carapace greater than depth in region of caudo-dorsal margin of cervical groove. Greatest width of carapace slightly caudad of caudo-dorsal margin of cervical groove.

Areola moderately broad (4.1 times longer than wide); 3-4 punctuations in its narrowest part; sides parallel for a short distance in middle. Cephalic section of carapace about 1.9 times as long as areola.

Rostrum acute, lanceolate; apex reaching almost to tip of last segment of peduncle of antennule; upper surface excavate, sparsely punctate with scattered fine hairs, and a row of setae along each inner dorsal margin (several very long ones). Margins subparallel and uninterrupted, gently converging distad to form a long acumen. Apex of rostrum directed slightly dorsad, distinctly acuminate. Subrostral ridge prominent, Postorbital ridges terminating in small, acute spines. Suborbital angle absent; cephalo-lateral margins of carapace only slightly irregular. Branchiostegal spines well developed.

Surface of carapace sparsely punctate; granulate laterally. Cephalo-lateral regions polished, with a few small tubercles. No lateral spines, instead a single small tubercle present on either side.

Abdomen longer than carapace (1.87-1.68 cm.).

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1 Contribution from the Department of Biology, University of Florida.

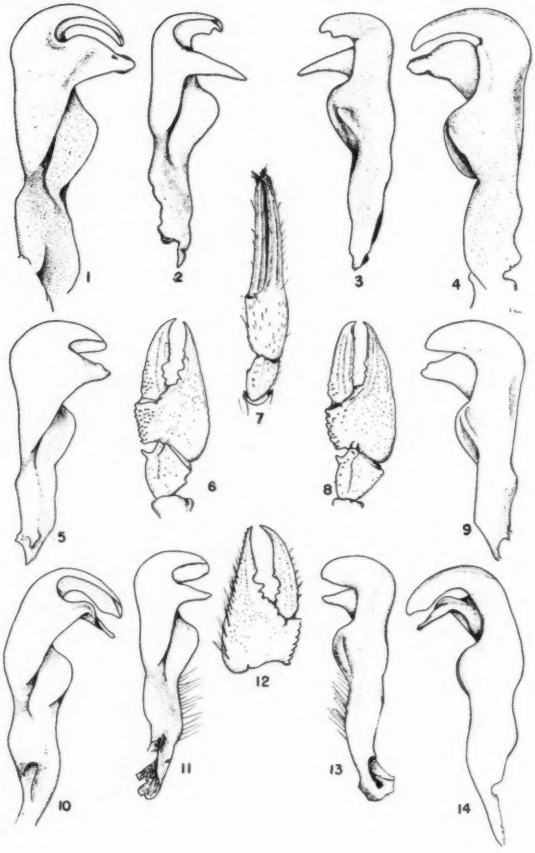

PLATE 1: Fig. 1. Mesial view of first pleopod (male form I) *Cambarus floridanus*. Fig. 2. Mesial view of first pleopod (male form I) *Cambarus cryptodytes*. Fig. 3. Lateral view of first pleopod (male form I) *Cambarus cryptodytes*. Fig. 4. Lateral view of first pleopod (male form I) *Cambarus floridanus*. Fig. 5. Mesial view of first pleopod (male form II) *Cambarus floridanus*. Fig. 6. Upper view of right chela of *Cambarus byersi*. Fig. 7. Upper view of right chela of *Cambarus cryptodytes*. Fig. 8. Upper view of right chela of *Cambarus floridanus*. Fig. 9. Lateral view of first pleopod (male form II) *Cambarus floridanus*. Fig. 10. Mesial view of first pleopod (male form I) *Cambarus byersi*. Fig. 11. Mesial view of first pleopod (male form II) *Cambarus cryptodytes*. Fig. 12. Lower view of right chela of *Cambarus byersi*. Fig. 13. Lateral view of first pleopod (male form II) *Cambarus cryptodytes*. Fig. 14. Lateral view of first pleopod (male form I) *Cambarus byersi*.

Anterior section of telson with one spine in the left postero-lateral angle and two in the right.

Anterior margin of epistome (Fig. 15) roughly isosceles-trapezoid shaped; without median anteriorly projecting spine; broader than long.

Antennules of the usual form; a spine present on ventral side of basal segment.

Antennae about 1.5 times as long as body. Antennal scale broad (Fig. 29), extending to distal tip of second joint of peduncle of antennule; spine on outer distal margin moderately strong.

First pereiopod (Fig. 7) slender and elongate with tip of dactyl passing beneath the tip of propodus when fingers are brought together. Hand sparsely punctate above and below; lateral and mesial sides with small scattered tubercles. A distinct ridge present on dorsal surface of both fingers. Small ridge along dorsal surface of palm at articulation with dactyl.

Movable finger with minute denticles running the entire length along lateral margin; 6 small corneous teeth are present along basal third of same margin; dorsal surface with a prominent submedian ridge extending from the base almost to the tip of the finger. Outer surface studded with scattered setae, as are also mesial and lower surfaces. Tip of finger recurved (outward) and corneous.

Immovable finger with minute denticles running the entire length along inner (mesial) margin; 4 small teeth present along basal fifth of same margin and a larger corneous tooth projecting from the ventral margin (mesially) at the tip of the basal third. Dorsal and ventral surfaces with prominent longitudinal ridges. Scattered setae are distributed over the entire finger, especially thickly near the tip.

Carpus longer than wide, not as long as inner margin of the palm of the chela; a shallow longitudinal groove above; sparsely punctate over entire surface; a few tubercles and three small spines present on mesial surface; proximal spine the smaller.

Merus smooth on inner and outer surfaces; lower inner margin with 11 spines and lower outer margin with 10 spines; upper edge with about 13 tubercles.

Hooks present on ischiopodites of third pereiopods only; hooks strong (Fig. 28).

First pleopod (Figs. 2 and 3) reaching to base of third pereiopod; terminating distad in two parts. Central projection (outer part) corneous, bladelike, curved at right angles with the main shaft, caudo-distal margin with deep emargination. Mesial process (inner part) noncorneous and exceeding the central projection caudo-distad and though straight is directed at about a 110 degree angle with the main shaft. A decided tubercle is present on the caudo-lateral surface at base of central projection. An oblique ridge is present on the caudo-lateral surface of the hump (slightly distad of midlength).

Male (Form II).—Agrees in most points with the first form male. Anterior section of telson with only one spine in each postero-lateral corner. Hooks on ischiopodites of third pereiopods reduced. First pleopod (Figs. 11, 13) with noncorneous tips, both reduced and more fleshy; mesial process barely exceeding the central projection distad.

Allotypic Female.—Similar to the male form I; however, anterior section of telson with only one spine in each posterolateral corner, and epistome not as decidedly trapezoidal. Annulus (Fig. 24) with sinus originating some distance caudad of the cephalic border near midventral line, curves gently to the left caudad of middle, then suddenly to the right, and finally, gently to the left to cut the caudal margin slightly to the right of the midventral line. Just posterior to the annulus the sternum is modified into a small subelliptical protuberance.

Measurements.—Male (Form I) Holotype: carapace, height .67, width .75, length 1.68 cm.; areola, width .16, length .65 cm.; rostrum, width .20, length .37 cm.; abdomen, length 1.87 cm.; right chela, length of inner margin of palm .37, width of palm .28, length of outer margin of hand 1.21, length of movable finger 1.92 cm.; antenna, length 5.1 cm. Female Allotype: carapace, height .62, width .72, length 1.55 cm.; areola, width .15, length .60 cm.; rostrum, width .18, length .35 cm.; abdomen, length 1.80 cm.; right chela, length of inner margin of palm .35, width of palm .25, length of outer margin of hand 1.09, length of movable finger 1.71 cm.; antenna, length 4.68 cm.

Type Locality.—Two miles south of Graceville, Jackson County, Florida. All of my specimens were taken, during a period of two years, from a well about 60 feet deep on the farm of Mr. R. W. Williams.

Disposition of Types.—The male holotype and the female allotype, U. S. N. M. nos. 79339, 79340, and a second form male paratype are deposited in the United States National Museum. Of the remaining paratypes one female has been deposited in the Museum of Comparative Zoology; one female, one immature male, and one immature female are retained in my personal collection.

Relationships.—*Cambarus cryptodytes* probably has its closest affinities with the southern Appalachian *bartonii* group. The lack of spines on the rostrum and the sparsity of punctuations in the areola, as well as its width, exclude the possibility of its relationship with the groups of *rusticus, montanus,* longulus, or *diogenes.* The Florida species belonging to the *bartonii* group are *Cambarus latimanus* and *Cambarus floridanus,* and the latter is found within 20 miles of the single known locality of *Cambarus cryptodytes.* Thus it is at least possible that these two species were derived from a common Appalachian stock that migrated southward into Florida.

Remarks.—With the discovery of *Cambarus cryptodytes* five cavernicolous species of the subgenus *Cambarus* are now known to inhabit the subterranean waters of North America.

The first of these, *Cambarus hamulatus*, taken from Nickajack Cave, Tennessee, was described in 1881 by Cope and Packard. In 1898, Faxon described *Cambarus setosus* from Wilson's Cave, Jasper County, Missouri, and, in 1902, Steele described *Cambarus ayersii* from Fisher's Cave, near Springfield, Green County, Missouri. The same year Hay published a description of "*Cambarus bartonii tenebrosus*," a spelean species, from Mammoth Cave, Edmundson County, Kentucky.

Cambarus (Cambarus) floridanus sp. nov.
(Figs. 1, 4, 5, 8, 9, 16, 19, 22, 25, 31, 32)

Diagnosis.—*Cambarus floridanus* is a member of the subgenus *Cambarus* (i. e., first pleopod of male terminating in two distinct parts which are bent at approximately right angles with the main shaft) which appears to be an habitual burrower in seepage areas and along creek margins. Rostrum without lateral spines; carapace granulate; hands tuberculate with two distinct rows along inner margin of palm; length of the areola ranges from 37.2 to 41.1% of the entire length of the carapace; one or two rows of dots (punctations) in narrowest part of areola.

Holotypic Male, Form I.—Body subovate, compressed dorso-ventrally. Abdomen narrower than thorax (1.05-1.37 cm. in widest parts respectively).

Width of carapace greater than depth in region of caudo dorsal margin of cervical groove. Greatest width of carapace slightly caudad of caudo-dorsal margin of cervical groove.

Areola narrow (13 times longer than wide); 1-2 punctation in its narrowest part; sides parallel for a short distance at midlength. Cephalic section of carapace about 1.53 times as long as areola (length of areola, 39.5% of entire length of carapace).

Rostrum deeply excavate; margins subparallel converging anteriorly and turning mesad at about 45 degree angles to form the small acumen which extends cephalad almost to base of last segment of peduncle of antennule. Upper surface sparsely punctate with a row of setiferous punctation along inner margin of lateral ridges; ridges slightly swollen and continuous cephalad to apex. (No lateral spines present). Extreme tip slightly upturned and blunt. Subrostral ridge rather weak. Cephalic region of carapace in lateral aspect decidedly humped. Postorbital ridges terminating cephalad without a spine. Suborbital angle obtuse, barely evident; branchiostegal spines absent.

Surface of carapace densely punctate and heavily granulate laterally, decidedly so in cephalic region. No lateral spines; instead one or two large tubercles present in that region.

Abdomen shorter than carapace (2.52-2.66 cm.).

Anterior section of telson with 3 spines in the postero-lateral corner and two in the left.

Epistome (Fig. 16) slightly broader than long; roughly triangular; shallow emarginations present along margins.

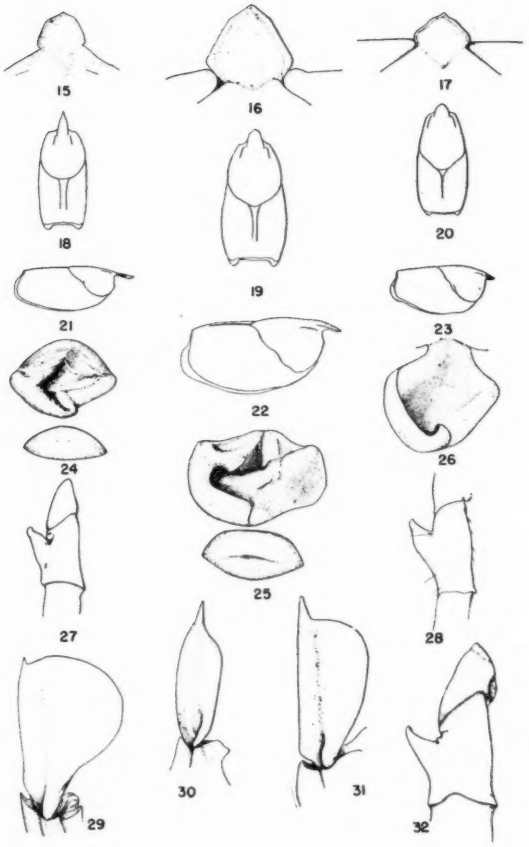

PLATE 2: Fig. 15. Epistome of *Cambarus cryptodytes*. Fig. 16. Epistome of *Cambarus floridanus*. Fig. 17. Epistome of *Cambarus byersi*. Fig. 18. Dorsal view of carapace of *Cambarus cryptodytes*. Fig. 19. Dorsal view of carapace *Cambarus floridanus*. Fig. 20. Dorsal view of carapace of *Cambarus byersi*. Fig. 21. Lateral view of carapace of *Cambarus cryptodytes*. Fig. 22. Lateral view of carapace of *Cambarus floridanus*. Fig. 23. Lateral view of carapace of *Cambarus byersi*. Fig. 24. Annulus ventralis of *Cambarus cryptodytes*. Fig. 25. Annulus ventralis of *Cambarus floridanus*. Fig. 26. Annulus ventralis of *Cambarus byersi*. Fig. 27. Ischiopodite of third pereiopod of *Cambarus byersi*. Fig. 28. Ischiopodite of third pereiopod of *Cambarus cryptodytes*. Fig. 29. Antennal scale of *Cambarus cryptodytes*. Fig. 30. Antennal scale of *Cambarus byersi*. Fig. 31. Antennal scale of *Cambarus floridanus*. Fig. 32. Ischiopodite of third pereiopod of *Cambarus floridanus*.

Antennules of the usual form; a spine present on ventral side of basal segment.

Antennae about 3.6 cm. long (measured from tip of rostrum) reaching caudad to second segment of abdomen. Antennal scale (Fig. 31) relatively narrow, extending to distal end of second joint of peduncle of antennule; spine on outer distal margin moderately strong.

First pereiopod (Fig. 8) broad and relatively short; tip of dactyl passing below tip of propodus when fingers are brought together. Hand with setiferous punctations dorso-laterad and ventrad; tuberculate dorso-mesiad. Lower submedian surface of hand with a few scattered prominent tubercles; two present along articulation of movable finger. Inner margin of palm with two rows of tubercles, a mesial row of 6, a more dorsal one of 5. Two tubercles are present below the mesial row between tubercles 3 and 4, and 4 and 5 (counting from proximal to distal end). A distinct ridge present on dorsal surface of both fingers. A decided ridge along dorsal surface of palm at articulation with dactyl. Fingers slightly gaping at base.

Movable finger with crowded denticles along distal half of lateral margin; 6 corneous teeth are present along basal half of same margin; dorsal surface with well defined median ridge extending from the base almost to tip of finger and subtended on either side by a row of setiferous punctations. Proximal fourth of mesial margin with several irregularly arranged tubercles which give way to a single row of setiferous punctations that extends to the tip of the finger. Three rows of setiferous punctations on under side of finger and a few scattered ones in addition on proximal fourth.

Immovable finger with crowded denticles along distal half of inner (mesial) margin; 5 knoblike tubercles and 1 small one along basal half of same margin and a large, more acute one projecting from the ventral margin distad of the smaller one just mentioned. Prominent ridge on outer margin; two ridges on dorsal surface, the more mesial one terminating at about the same level as the tubercle which extends from the ventral surface mesiad; the other extends to tip of finger. Setiferous punctations subtend all three ridges. Lower surface of finger with two rows of punctations and a few scattered ones at base.

Carpus longer than wide (.77-.55 cm.), longer than inner margin of palm of chela (.53 cm.); a well defined longitudinal groove above; punctate dorso-laterad, laterad, and ventrad; tuberculate dorso-mesiad and mesiad; three well defined spines on mesial surface, one proximal and two situated more distad; three prominent ones on ventro-distal surfaces, two of which are on distal margin.

Merus smooth on inner and outer surfaces except for a few scattered punctations; lower inner margin with 10 spikelike tubercles; lower outer margin with 7, upper surface with only two well defined tubercles.

Hooks present on ischiopodites of third pereiopods only; hooks strong (Fig. 32).

First pleopod (Figs. 1, 4) reaching to base of third pereiopod; terminating

in two distinct parts. Central projection (outer part) corneous, bladelike, recurved distad at approximately an hundred degree angle to the main shaft; caudo-distal margin entire (no emarginations). Distinct shoulder present on caudo-lateral margin at base of central projection. Mesial process (inner part) inflated, bulbous, noncorneous; directed much the same as central projection; however, slightly laterad. Cephalo-lateral surface with a large distinct depression. An oblique ridge is present across lateral surface of hump (at mid-length).

Male (Form II).—Agrees in general with first form male. Areola 40.8% of carapace; anterior section of telson with 2 spines in each postero-lateral corner. Epistome subtriangular with margins slightly undulate. Inner margin of right palm with mesial row of 8 tubercles; left much as in holotype; slight differences in arrangements of tubercles. First pleopod (Figs. 5, 9) similar to that in the first form male; however, no corneous parts and all parts blunter; tubercle on lateral surface at base of central projection in first form male, absent in second form male.

Allotypic Female.—Similar to the male form I; however, extreme tip of rostrum sharply upturned. Suborbital angle more prominent. Anterior section of telson with two spines in each postero-lateral corner. Epistome trapezoidal; antero-median spine present. Right hand with mesial row of 7 tubercles on inner margin; the more dorsal row composed of 4 tubercles. Left hand as in male form I; other slight differences in tubercle number and arrangements. Annulus ventralis (Fig. 25) roughly subrectangular. Sinus originating cephalad along midventral line, turning sharply dextrad, then caudad for a short distance; then sharply sinistrad, passing the midventral line, where it turns sharply caudad to cut the caudal margin. Sternum immediately cephalad of annulus V-shaped in caudal aspect (deep); sternum immediately caudad forming a subelliptical punctate prominence, bearing a transverse groove between middle and caudal third.

Measurements.—Male (Form I) Holotype: carapace, height 1.24, width 1.37, length 2.66 cm.; areola, width .08, length 1.05 cm.; rostrum, width .31, length .53 cm.; abdomen, length 2.52 cm.; right chela, length of inner margin of palm .53, width of palm .85, length of outer margin of hand 1.75, length of movable finger 1.92 cm. Female Allotype: carapace, height 1.25, width 1.63, length 3.08 cm.; areola, width .11, length 1.21 cm.; rostrum, width .45, length .66 cm.; abdomen, length 2.52 cm.; right chela, length of inner margin of palm .68, width of palm 1.02, length of outer margin of hand 2.06, length of movable finger 1.43 cm.

Type Locality.—"Cryptolabis Ravine," 12 miles west of Tallahassee on State Highway 19, Leon County, Florida. This ravine is one of several large, swampy, and mesophytic ravines draining into the Ochlocknee River. Burrows of *Cambarus floridanus* are scattered over the seepage areas and along the brook margins. All of the burrows are extremely rambling, and because they wind about among the many roots, digging for the crayfish is extremely difficult.

Disposition of Types.—The male holotype and the female allotype, U. S. N. M. no. 79341, and a second form male paratype are deposited in the United States National Museum. Of the remaining paratypes one male form I, and a female have been deposited in the Museum of Comparative Zoology; a male form II, and a female in the University of Michigan Museum of Zoology; one male form I, four males form II, five females, one male immature, and one female immature are in my personal collection.

Relationships.—With little doubt *Cambarus floridanus* has its closest affinities with *Cambarus latimanus*. The relatively narrow areola, the strongly granulate carapace, the rough chelae, and the general conformation of the rostrum are all definitely of the *latimanus* type.

Cambarus (Cambarus) byersi sp. nov.
(Figs. 6, 10, 14, 17, 20, 23, 26, 27, 30)

Diagnosis.—*Cambarus byersi* is a member of the subgenus *Cambarus* (i. e., first pleopod of male terminating in two distinct parts which are bent at approximately right angles to the main shaft) which is an habitual burrower in seepage areas, meadows, and along creek margins. Rostrum short, without lateral spines; areola obliterated; base of movable finger definitely excised; eyes reduced but pigmented; base of immovable finger of chela not bearded; a single row of setose punctations (setae very long) runs along the ventro-lateral surface of the hand.

Holotypic Male, Form I.—Body subovate; compressed laterally. Abdomen considerably narrower than thorax (.71-1.06 cm. in widest parts respectively).

Width of carapace slightly greater than depth in region of caudo-dorsal margin of cervical groove. Greatest width of carapace slightly caudad of caudo-dorsal margin of cervical groove.

Areola obliterated; cephalic section of carapace about 1.62 times as long as areola (length of areola 38.1% of entire length of carapace).

Rostrum directed cephalo-ventrad; upper surface deeply excavate cephalad; margins converge from base, making only slight angles to meet at apex; no distinct acumen evident; no lateral spines present; tip of rostrum extends cephalad to base of last segment of peduncle of antennule. Punctate above with a row of setiferous punctations along inner margins of lateral ridges; ridges slightly inflated caudad, extending to apex. Apex directed dorsad. Subrostral ridges very weak. Postorbital ridges terminate cephalad without a spine, obsolescent cephalad. Suborbital angle absent Branchiostegal spines absent.

Surface of carapace entirely punctate; no lateral spines present.

Abdomen shorter than carapace (1.32-2.23 cm.).

Anterior section of telson with one spine in each postero-lateral corner.

Epistome (Fig. 17) broader than long; subminaret shaped; spine on cephalic border short.

Eyes reduced but pigmented.

Antennules of the usual form; a spine present on ventral side of basal segment.

Antennae about 2 cm. long; not reaching caudal margin of carapace. Antennal scale small (Fig. 30), extends cephalad to about midlength of second joint of peduncle of antennule; spine on outer distal margin relatively strong; outer margin slightly convex laterad; inner margin of lamella gently rounded distad.

First pereiopod (Figs. 6, 12) (right) short, broad, compressed, with tip of dactyl passing beneath the tip of propodus when fingers are brought together. Hand punctate above and below; mesial margin with a row of 9 well defined tubercles subtended dorsad by a weaker and more irregular row of about 7 tubercles. A distinct ridge present on dorsal surface of both fingers. Outer margin of hand with a distinct ridge. Three tubercles present along articulation of movable finger on lower surface of hand.

Movable finger with minute denticles along distal two-thirds of lateral margin; lateral margin deeply excised on proximal third; 6 corneous tubercles present along basal two-thirds of same margin, decreasing in size in the following order from base: 1, 3, 2, 5, 6, 4; dorsal surface with 3 prominent ridges all fading out before reaching tip; the more lateral one rising near the base of finger and becoming obsolete at midlength; the mesial one arising just proximad of midlength and extending almost to the tip; the median ridge, the most prominent, arises at the base and extends to the middle of the distal third. Proximal third of mesial surface with scattered tubercles giving way to a row of setose punctations along the distal two-thirds. Finger entirely setose punctate.

Immovable finger with minute denticles along distal half of inner (mesial) margin. Four tubercles present along basal two-thirds decreasing in size in the following order (counting from base): 2, 3, 1, 4. Upper and lower surfaces mostly setose punctate. Upper surface with three ridges, the mesial one arising along articulation point of movable finger extends distad to midlength of immovable finger; the lateral one extends along the dorso-lateral margin of the hand, broken by tubercles, but regular for the distal two-thirds of the finger. Lower surface bearing a prominent median ridge arising at base of finger and extending to tip. A single row of setose punctations (setae conspicuously long) arising laterad of the latter ridge extends along the outer lower margin to base of immovable finger curving slightly inward but following the contour of the lateral margin of the hand (about 19 punctations in all, bearing from 3 to 8 setae, some .25 cm. in length).

Carpus longer than wide, longer than inner margin of palm of chelae; well defined longitudinal furrow above. Upper, ventro-mesial, and lateral margins setose punctate; dorso-mesial margin setose tuberculate. One large spine present on mesial surface.

Merus sparsely punctate dorsad and laterad, smooth mesiad. Lower inner margin with 12 tubercles and lower outer margin with 6. Ventral surface bearing scattered long hairs. Two small tubercles present on dorso-distal surface.

Margins of maxillipeds and second pereipods bearing long hairs.
Hooks present on ischiopodites of third pereiopods only (Fig. 27).
Venter with long hairs.

First pleopod (Figs. 10, 14) reaching to base of third pereiopods, terminating in two distinct parts. Central projection (outer part) corneous and blade-like, is recurved, making almost an 120 degree angle with the main shaft. Caudo-distal margin slightly emarginate. Mesial process, somewhat twisted and not bulbous, is directed approximately parallel to the central projection. The whole distal portion of the appendage is bent caudad.

Male (Form II).—The second form male is known from only three immature specimens.

Allotypic Female.—Differs only slightly from the male form I. Acumen slightly more distinct. Epistome with cephalo-lateral margins more nearly straight. Inner margin of palm with three distinct rows of tubercles; a mesial row of 10, a more dorsal row of 6, and a third row still more dorsal, of 5 tubercles. Other scattered tubercles are present on the mesio-dorsal surface. There are other differences in tubercle number and arrangement on the hand. Annulus ventralis subquadrate with the longitudinal axis passing through opposite angles. Cephalic margin fused with venter of cephalic thoracic region. Median surface flattened with the highest ridges on the caudo-lateral sides, the highest caudo dextrad. Cephalo-lateral ridges diminish cephalo-mesiad so that the cephalic angle is almost as flat as the median portion (only a low mound present at cephalic angle). Caudo-dextral wall overhangs the fossa which disappears slightly sinistrad of the midventral line near the caudal tip of the annulus.

Measurements.—Male (Form I) Holotype: carapace, height 1.00, width 1.06, length 2.23 cm.; areola, width 0.0, length .85 cm.; rostrum, width .33, length .27 cm.; abdomen, length 1.82 cm.; right chela, length of inner margin of palm .41, width of palm .74, length of outer margin of hand 1.43, length of movable finger .99 cm. Female Allotype: carapace, height 1.02, width 1.07, length 2.30 cm:; areola, width 0.0, length .90 cm.; rostrum, width .34, length .28 cm.; abdomen, length 1.89 cm.; right chela, length of inner margin of palm .43, width of palm .73, length of outer margin of hand 1.34, length of movable finger .93 cm.

Type Locality.—A narrow swampy area along Phifer Creek, 5.5 miles northwest of Pensacola, Escambia County, Florida, near United States Highway 90. The soil in this area is a mixture of hard, black muck and sand. Sphagnum, orchids, and pitcher plants are abundant in the open areas. The crayfish burrows are very complex and are so interwoven among the roots of the luxuriant vegetation that they are difficult to dig out. The crayfish are strikingly colored with orchid and yellow areas; in one of the males the entire dorsum was orchid and the venter and lateral surfaces were pale yellow. The chelae always have a purplish cast.

Disposition of Types.—The male holotype and the female allotype, U. S. N. M. no. 79342, are deposited in the United States National Museum. Of the remaining paratypes one female has been deposited in the Museum of Comparative Zoology; one female in the University of Michigan Museum of Zoology; one male form I, 3 females, 3 immature males, and 2 immature females are in my personal collection.

Relationships.—*Cambarus byersi* has its affinities with the Section of *Cambarus diogenes* (Ortmann 1905:119).[2] It seems to be most closely related to *Cambarus fodiens*. The movable finger has a distinct excision at the base; the first pleopod is similar and the general body conformation is that of *fodiens*.

It is a pleasure to name this species in honor of Professor C. Francis Byers, of the University of Florida, who has given me numerous invaluable suggestions and criticisms in my work on crayfishes.

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2 The Mutual Affinities of the Species of the Genus *Cambarus*, and Their Dispersal over the United States. Proc. Amer. Philos. Soc. Philad. **44**(180):91-136, Map. 1905.

Contributions to a Synopsis of the Hemiptera of Missouri, Pt. I.*

Scutelleridae, Podopidae, Pentatomidae, Cydnidae, Thyreocoridae

R. C. Froeschner

The need for systematic entomological work in Missouri is great. No real attempt has ever been made to prepare a check-list of the insects of the state. Taxonomic papers dealing primarily with Missouri material and attempting to gather records for all species occurring in the state, even for a very limited group, are so few in number that they can be counted on the fingers of one hand. When we consider Missouri's central geographic location, its diverse topographic areas and its division into life zones, we realize that it occupies a very important position in relation to the problem of insect distribution. In it many southern, eastern, northern and western forms reach the northern, western, southern and eastern limits of their respective ranges. Many intergrading individuals of various geographic groups occur in the state and make the taxonomist's work even more difficult. This situation shows clearly the great need for work to relate properly Missouri's insect fauna with that of adjacent areas. For this purpose the following contribution on the Hemiptera of Missouri is offered as the first of a series dealing with this and other groups.

Because of the lack of previous work and the absence of any comprehensive collections of Missouri insects, this paper is, of necessity, far from being complete not only as to the species recorded, but also concerning the data on local geographical and seasonal distribution. Some of the older records accredit to Missouri certain species which have never been found in the state. These records, like that of Say for *Thyreocoris albipennis* which has been found no farther east than Kansas, were made at a time when Missouri did not exist as a state and the name was used, as Henry Osborn said, "meaning all the central part of the United States as secured by the Louisiana Purchase." These records must also be checked and corrected to make our lists and catalogs as accurate as possible. The collection of the Division of Entomology and the author's personal one formed the nucleus for this work. Whenever possible, additional collections were inspected and the data so obtained were incorporated. Records from specimens not collected by the author bear the initials of the person responsible for them, whereas others are attributable to the author. For most species, the distribution as to time and locality is indicated by month and county records.

The following is a list of the names of collectors indicated in the text by their initials.

A. G. Peterson—Former graduate student in Entomology at the University of Missouri.

* Contribution No. 1. Division of Entomology, Missouri State Department of Agriculture.

C. Aufranc—Assistant Entomologist at the Missouri State Department of Agriculture.
C. M. Graham—Assistant Entomologist at the Missouri State Department of Agriculture.
C. Wingo—Research Assistant in Entomology at the University of Missouri.
D. Damon—Former Senior Foreman Wildlife Technician at the Lake-of-the-Ozarks Recreational Area.
E. Herbold—Biological artist at the University of Missouri.
E. P. Meiners—A physician in St. Louis who is keenly interested in entomology, especially for Missouri.
H. E. Brown—Instructor in Entomology at the University of Missouri.
Japanese Beetle traps—set up in St. Louis in connection with the Japanese beetle suppression work going on there.
MSTC—Central Missouri State Teachers' College Collection at Warrensburg. For permission to use the records from this collection, I am indebted to Mrs. Maude Nattinger of that institution.
S.D.A.—In collection of Missouri State Department of Agriculture but no collector given.
R. I. Wakeman—Private collector and University student from St. Joseph.
W. R. Enns—Private collector and University student from Columbia.
W. S. Craig—Private collector and University student from New Hartford.
W. W. Smith—Research Assistant in Entomology at the University of Missouri.

The keys are so constructed that by use of the second figures (in parentheses) one may run through them backwards or forwards from any couplet.

The plates are made up of original drawings by Miss Elsie Herbold, biological artist at the University of Missouri.

Special thanks are due to Mr. H. G. Barber of the Bureau of Insect Identification for determining the specimen of *Mecidea longula* as well as most of my Thyreocoridae. I am also indebted to Dr. Leonard Haseman for permission to use the records from the University of Missouri collection.

The order Hemiptera is a very important one in regard to man's welfare. Among its members are many of our more serious pests such as the Harlequin Cabbage Bug, Squash-bug, Chinch Bug, Bed-bug and Tarnished Plant-bug. But this order also contains some of our very valuable allies, such as the Spined and the Bordered Soldier-bugs which feed on many of the soft bodied plant-eating forms of this and other orders. We can also list among Man's friends in this order many of the predaceous groups such as the Nabidae or Damsel-bugs, some of the Assassin-bugs, family Reduviidae, and numerous species of other groups.

The Hemiptera are characterized by prognathous mouth-parts used for piercing and sucking; also, in the winged members there are usually two pairs of wings present, the front pair of which is variously thickened at the base and usually thinner and overlapping at the apex. The life cycle consists of three primary divisions: the egg-stage, the immature or nymph stage which is the growing period, and the adult stage. When, as is the case here, the immature stages differ from the adults only in size and by the absence of wings, both of which are gradually obtained during growth, the life cycle is known as a gradual metamorphosis.

The following key is based on various sources, especially on that found in Comstock's "Introduction to Entomology."

KEY TO THE MISSOURI FAMILIES OF HEMIPTERA

1. Antennae as long or longer than head, exposed 2
Antennae shorter than head, usually concealed in cavities beneath the head....27

2. (1). Antennae with five segments, III to V not noticeably narrower than II; beak 4-segmented 3
Antennae with four segments, if with five, then segments III to V are much narrower than II or the beak is with but three segments 7

3. (2). Tibiae distinctly spinose. (Fig. 1) 4
Tibiae not spinose 5

4. (3). Scutellum of moderate size, triangular, not approaching apex of abdomen; corium exposed, broadly triangular. (Fig. 3) ..... *Cydnidae*
Scutellum very large and U-shaped, covering abdomen to apex; corium largely membranous, the exposed portion narrow. (Figs. 2, 24 & 27) ..... *Thyreocoridae*

5. (3). Scutellum very large and U-shaped, nearly or quite reaching apex of abdomen (Fig. 2); front tibiae never expanded; opaque part of corium greatly narrowed 6
Scutellum subtriangular (Fig. 3), rarely somewhat U-shaped and approaching apex of abdomen (Fig. 35) in which case the front tibiae are expanded; opaque part of corium broad and subtriangular ..... *Pentatomidae*

6. (5). Sides of pronotum with a prominent tooth or lobe in front of the humeral angles and another on front angles; eyes protuberant or stylated (Fig. 5) ..... *Podopidae*
Sides of pronotum not so toothed; eyes never protuberant..... *Scutelleridae*

7. (2). Last segment of tarsi entire, claws inserted at apex 8
Last segment of tarsi more or less cleft, claws inserted before apex 26

8. (7). Head always much shorter than the thorax 9
Head much longer than all three segments of thorax united; body linear ..... *Hydrometridae*

9. (8). Hemelytra without a cuneus 10
Hemelytra with a cuneus 25

10. (9). Beak distinctly 4-segmented 11
Beak 3-segmented, or if 4-segmented the first segment is so short as to be not obvious 18

11. (10). Tarsi 3-segmented 12
Tarsi 2-segmented 15

12. (11). Ocelli present 13
Ocelli absent ..... *Pyrrhocoridae*

13. (12). Head without a transverse sulcus; body and appendages not linear..... 14
Head with a transverse sulcus; body and appendages extremely slender, linear ..... *Neididae*

14. (13). Membrane of hemelytra with numerous more or less anastomosing veins; antennae inserted above an imaginary line drawn from the front end of the bucculae to the middle of the eyes ..... *Coreidae*
Membrane of hemelytra with four or five simple veins arising from a transverse basal vein; antennae inserted on or below the imaginary line drawn from the front end of the bucculae to the middle of the eyes ..... *Lygaeidae*

15. (11). Hemelytra neither lacelike nor closely reticulated to form numerous small cells 16
Hemelytra lace-like or closely reticulated to form numerous small cells..... 17

16. (15). Ocelli absent; body strongly flattened above and beneath, not pilose... *Aradidae*
Ocelli present; body not strongly flattened, heavily pilose; antennae 4-

or 5-segmented, segments I and II much stouter than the others..... *Naeogeidae*

17.(15). Membrane well defined, not reticulate; jugae longer than tylus.....*Piesmidae*
Membrane reticulate, not differentiated from corium; jugae not longer than tylus .....*Tingididae*

18.(10). Pronotum with no transverse grooves 19
Pronotum with at least one transverse groove 21

19.(18). Ocelli present 20
Ocelli absent; hemelytra reduced to mere pads without membranes....*Cimicidae*

20.(19). Membrane when present without veins; color greenish.....*Mesoveliidae*
Membrane present and with distinct veins forming two to five elongate cells; color black, sometimes marked with white or yellow.....*Saldidae*

21.(18). Pronotum divided into three lobes by two transverse sulci.....*Enicocephalidae*
Pronotum with but one transverse sulcus 22

22.(21). Antennal IV much thickened, fusiform; front legs with femora very stout, tibiae short and retractile .....*Phymatidae*
Antennal IV slender, not strongly fusiform; front femora not very stout.....23

23.(22). Head with transverse groove between or behind eyes; beak 3-segmented.....24
Head without a transverse groove; beak 4-segmented, first segment very short .....*Nabidae*

24.(23). Body and antennae extremely slender, linear; ocelli absent; hemelytra membranous throughout .....*Ploiariidae*
Body stouter; ocelli usually present; hemelytra in great part coriaceous.... .....*Reduviidae*

25. (9). Ocelli present .....*Anthocoridae*
Ocelli absent .....*Miridae*

26. (7). Hind femora much surpassing apex of abdomen; middle and hind coxae approximate, distant from front ones .....*Gerridae*
Hind femora but little if any surpassing apex of abdomen; middle and hind coxae well separated .....*Veliidae*

27. (1). Ocelli present 28
Ocelli absent 29

28.(27). Antennae exposed; beak reaching at least to hind coxae.....*Ochteridae*
Antennae concealed; beak short, concealed by front femora.....*Gelastocoridae*

29.(27). Hind tarsi with two distinct claws; front legs with tibiae capable of being pressed against femora, in other words, front legs fitted for grasping.....30
Hind tarsi clawless (except in *Plea* which is less than 3 mm. in length); front legs not fitted for grasping 31

30.(29). Tarsi 1-segmented; hind legs not flattened .....*Nepidae*
Tarsi 2-segmented; hind legs flattened .....*Belostomatidae*

31.(29). Head inserted in the prothorax; dorsum convex .....*Notonectidae*
Head overlapping apex of prothorax; dorsum subdepressed .....*Corixidae*

KEYS TO THE MISSOURI SUBFAMILIES, GENERA, AND SPECIES OF SCUTELLERIDAE

1. Ventrals IV and V each with a finely striated area on either side of the middle.....Subfamily *Tetyrinae* 2
Ventrals without such striated areas .....Subfamily *Odontotarsinae* 5

2.(1). Pronotum without transverse submedian groove; ostiole continuing as a distinct canal (Fig. 8).....3
Pronotum with a distinct transverse submedian groove; ostiole not continued as a canal 4

3.(2). Antennal II distinctly longer than III; ostiolar canal nearly straight..I. *Stethaulax*
Antennal II distinctly shorter than III; ostiolar canal distinctly curved forward near tip .....II. *Homaemus*

4.(2). Side margins of head and pronotum finely denticulate.....III. *Acantholoma*
Side margins of head and pronotum not denticulate.....IV. *Camirus*

5.(1). Scutellum broadly oval, covering apical two-thirds of costal margin of corium; ostiole without evident canal.....V. *Phimodera*
Scutellum narrow, oblong, not covering any portion of the costal margin of the corium; ostiole extended as a canal .....*VI. Eurygaster*

I. *Stethaulax* Bergroth

1. Dull reddish-brown, irregularly mottled with fuscous; length 6-7.5 mm. .....1. *marmoratus* (Say)

II. *Homaemus* Dallas

1. Head without pale margins; costal margin of coria marked with black; length 7-9 mm. .....2. *aeneifrons* (Say)
Head with pale margins or submargins; costal margins of coria pale throughout 2

2.(1). Side margins of pronotum straight; ventrals without lateral black spots; length 6.5-8 mm. .....3. *bijugis* Uhl.
Side margins of pronotum feebly but evidently concave at middle; ventrals with black spot near lateral posterior angles; length 4.5-6 mm. .....4. *parvulus* (Germ.) (Fig. 20)

III. *Acantholoma* Stal

1. Dull black, minutely pubescent with yellowish prostrate hairs; length 5.3-5.8 mm.....8. *denticulata* Stal

IV. *Camirus* Stel

1. Carinate margin of head distinctly bent before the eyes; pronotum with anterior angles rounded; length 4-4.5 mm.....7. *porosus* (Germ.)

V. *Phimodera* Germar

1. Pronotum with anterior angles subacute; marginal tubercle of abdomen not prominent; length 6.5-7 mm.....5. *binotata* (Say)

VI. *Eurygaster* Laporte

1. Antennal III shorter than IV; length 6.5-9 mm.....6. *alternata* (Say)

KEYS TO THE MISSOURI GENUS AND SPECIES OF PODOPIDAE

1. Jugae but slightly longer than tylus, not contiguous in front of it; antennal tubercles armed on outer angle with a curved spine.....I. *Podops*

I. *Podops* Laporte

1. Venter of abdomen more sparsely punctate at middle; pronotum with margin between apical and humeral lobes distinctly but not deeply sinuate (Fig. 5); length 6-6.5 mm.....9. *cinctipes* Say (Fig. 21)
Venter of abdomen uniformly punctured throughout; pronotum with margin between apical and humeral lobes straight; length 5-5.5 mm. .....10. *parvulus* VanD.

KEYS TE THE MISSOURI SUBFAMILIES, TRIBES, GENERA AND SPECIES OF PENTATOMIDAE

1. Bucculae parallel and widely spaced, first segment of beak imbedded between them (Fig. 9).....Subfamily *Pentatominae* 2
Bucculae converging and uniting posteriorly, only base of first segment of

beak imbedded between them (Fig. 10).....Subfamily *Asopinae* 23

2.(1). Body elongate, about four times as long as broad; antennal II dilated on inner side.....Tribe *Mecidiini;* I. *Mecidea*

Body broader, not over three times as long as broad; antennal II not dilated on inner side 3

3.(2). Jugae toothed laterally near apex; side marging of pronotum with numerous coarse teeth (Fig. 6).....Tribe *Halyini;* II. *Brochymena*

Jugae not toothed laterally near apex; side marging of pronotum without coarse teeth (Fig. 7).....Tribe *Pentatomini* 4

4.(3). Middle of second ventral not produced forward as a spine or tubercle..... 5

Middle of second ventral produced forward toward or between posterior coxae as a stout spine or tubercle.....21

5.(4). Ostiolar opening without a distinct, free-edged auricle, but continued as a narrow, tapering, evanescent canal (Fig. 14 & 16)..... 6

Ostiolar opening with a short, curved, raised auricle and never with more than a short, abruptly-ending canal (Fig. 11).....10

6.(5). Jugae longer than and contiguous or nearly so in front of the tylus..... 7

Jugae not longer than tylus..... 8

7.(6). Lateral margins of pronotum straight, smooth and pale; antennal II longer than I .....III. *Peribalus*

Lateral margins of pronotum angulately concave, not paler than disk; antennal II shorter than I .....XXI. *Dendrocoris*

8.(6). Ostiolar canal not reaching beyond the middle of its supporting plate (Fig. 14) 9

Ostiolar canal continued as a ridge and extending obliquely to the outer front margin of its supporting plate (Fig. 16).....VI. *Thyanta*

9.(8). Size smaller, 8 mm. or less; color brown with pale markings; distinctly pubescent beneath .....IV. *Trichopepla*

Size larger, 10 mm. or more; color predominantly green; not pubescent .....V. *Chlorochroa*

10.(5). Side margins of head not reflexed; head not deflexed (if so, then apical third of scutellum not strongly narrowed (Fig. 4) 11

Side margins of head reflexed; head strongly deflexed, front nearly vertical (Fig. 12); color black with red or yellow variegations..... .....XVIII. *Murgantia*

11.(10). Scutellum shorter than coria, its apical third narrowed, apex not broadly rounded (Fig. 3) 12

Scutellum equalling or surpassing coria, its apical third not narrowed, apex broadly rounded (Fig. 4).....18

12.(11). Humeral angles without an obtuse, projecting process with emargination behind (Fig. 7); sides of abdomen never strongly serrate.....13

Humeral angles of pronotum with a distinct obtuse process which is emarginate behind (Fig. 18); sides of abdomen strongly serrate (Fig. 18) .....XIII. *Prionosoma*

13.(12). Hind tibiae smoothly rounded above, at least on basal half.....14

Hind tibiae sulcate above throughout their entire length.....16

14.(13). Humeral angles not spined; scutellum with smooth, white margins..... .....VII. *Mormidea*

Humeral angles spined; scutellum not margined with pale.....15

15.(14). Humeral spines directed forward; tylus rounded, scarcely exceeding jugae .....VIII. *Solubea*

Humeral spines directed outward; tylus pointed, greatly exceeding jugae

.....IX. *Proxys*

16.(13). Side margins of pronotum crenulate anteriorly; humeral angles prominent .....X. *Euschistus*

Sides of pronotum entire, humeral angles rounded.....17

17.(16). Margins of pronotum in front of middle not strongly flattened; bucculae ending abruptly behind .....XI. *Hymenarcys*

Margins of pronotum flattened and expanded in front of middle; bucculae sloping off posteriorly .....XII. *Menecles*

18.(11). Jugae not surpassing apex of tylus 19

Jugae surpassing and usually contiguous in front of tylus.....20

19.(18). Front half of pronotum strongly declivitous; color black and red or black and yellow .....XVII. *Cosmopepla*

Front half of pronotum not declivitous; color clay-yellow with fuscous punctures .....XIV. *Coenus*

20.(18). Smaller, 6 mm. or less; general color dark with a pale calloused line at each basal angle of scutellum.....XV. *Neottiglossa*

Larger, 7 mm. or more; color pale with longitudinal fuscous lines..... .....XVI. *Aelia*

21.(4). Jugae not surpassing tylus 22

Jugae surpassing and contiguous before tylus.....XXI. *Dendrocoris*

22.(21). Size larger, 14 mm. or more; antennal II more than half the length of V; ventral II distinctly spinose .....XIX. *Acrosternum*

Size smaller, 11 mm. or less; antennal II less than half as long as V; ventral II merely obtusely tuberculate.....XX. *Banasa*

23.(1). Front femora with small spine below on apical third or fourth.....24

Front femora not so armed.....25

24.(23). Scutellum large. U-shaped, almost reaching apex of abdomen; spine of second ventral reaching middle coxae .....XXII. *Stiretrus*

Scutellum smaller, not approaching apex of abdomen; spine of second ventral not surpassing hind coxae.....XXIII. *Perillus*

25.(23). Segment IV of beak twice as long as III; side margins of pronotum entire .....XXIV. *Mineus*

Segment IV of beak subequal to III; side margins of pronotum crenate.....26

26.(25). Jugae slightly surpassing apex of tylus; length more than 14 mm..... .....XXV. *Apateticus*

Jugae equalling tylus; length less than 12 mm.....XXVI. *Podisus*

I. *Mecidea* Dallas

1. Clay-yellow with narrow fuscous stripes extending from either side of tylus back over head to base of pronotum, also from anterior angles to base of pronotum; scutellum long, narrow and with a smooth, longitudinal carina; length 11-13 mm. .....11. *longula* Stal

II. *Brochymena* Amyot & Serville

1. Humeral angles of pronotum produced as a short, dentate and truncate lobe; ostiole with neither auricle nor canal; length 12-17 mm..... .....12. *arborea* (Say) (Fig. 22)

Humeral angles not truncated, either rounded or oblique anteriorly and sinuately serrate; ostiole with distinct auricle 2

2.(1). Jugae much longer than tylus; antennal II shorter than III; length 14-18 mm. .....13. *quadripustulata* (Fab.)

Jugae subequal to tylus; antennal II not shorter than III..... 3

3.(2). Apex of head triangular, distinctly produced in front of jugal tooth;

ostiolar auricle surrounded by a dark patch; length 17-19 mm.....
.....14. *cariosa* Stal

Apex of head subtruncate, but little produced in front of jugal tooth; ostiolar auricle surrounded by a pale patch; length 17 mm.....
.....15. *species-?*

III. *Peribalus* Mulsant & Rey

1. Tip of scutellum and margin of connexivum pale and smooth; under surface pale; length 7-9 mm.....16. *limbolarius* Stal (Fig. 28)

IV. *Trichopepla* Stal

1. Head distinctly longer than width across eyes; antennal II longer than III; length 6-8 mm. .....17. *semivittata* (Say)

V. *Chlorochroa* Stal

1. Numerous small, pale spots scattered over entire upper surface, except on membrane; scutellum with basal and apical spots larger; length 11-12 mm. .....19. *sayi* Stal

No pale spots on upper surface except a few inconspicuous ones at base and apex of scutellum; length 11-15 mm. .....18. *uhleri* Stal

VI. *Thyanta* Stal

1. Antennal II subequal to III; length more than 9 mm. 2

Antennal II twice as long as III; length 7 mm. or less.....22. *rugulosa* (Say)

2.(1). Pronotum with side margins shining black; form oval; length 9-10 mm.
.....20. *calceata* (Say)

Pronotum never with side margins black, usually green, sometimes red or yellow; form elongate; length 9-12 mm. ....21. *custator* (Fab.) (Fig. 33)

VII. *Mormidea* Amyot & Serville

1. Head deflexed; bucculae black; pronotum with narrow, transverse, pale bar before middle; length 5.5-7 mm. .....23. *lugens* (Fab.)

VIII. *Solubea* Bergroth

1. Dull greenish- or brownish-yellow, punctured with fuscous; spiracles black; length 9-12 mm. .....24. *pugnax* (Fab.) (Fig. 19)

IX. *Proxys* Spinola

1. Black, tip of scutellum and most of legs yellow; beak reaching onto ventral II; length 11-13 mm. .....25. *punctulatus* (Beauv.)

X. *Euschistus* Dallas

1. Ventrals with distinct black spots at anterior lateral angles 2
Ventrals without such black spots 5

2.(1). Side margins of pronotum concave, pale margin not bordered within by a row of contiguous black punctures; length 12 mm. or more. 3

Side margins of pronotum straight, pale margin bordered within by a row of contiguous black punctures; length 8.5-10 mm. .....28. *politus* Uhl.

3.(2). Venter of abdomen with at least one, usually a row of median black spots; length 9-11 mm. .....29. *tristigmus* (Say)

a. Humeri broad, subtriangular; under surface yellow .....
.....29. *t. tristigmus* (Say)

aa. Humeri narrow, more inclined upward and backward, their tips acutely angled or spinose; under surface dull white.....
.....29a. *t. pyrrhocerus* (H-S)

Venter of abdomen without median black spots 4

4.(3). Jugae distinctly surpassing apex of tylus; two apical segments of antennae usually fuscous; length 12-15 mm. .....27. *euschistoides* (Voll.)

Jugae equalling or but slightly surpassing apex of tylus; antennae pale throughout; length 12.5-15 mm. .....26. *servus* (Say)

5.(1). Spiracular rings pale; no evident, raised, smooth interhumeral pale line; length 11-15 mm. .....30. *variolarius* (Beauv.) (Fig. 31)

Spiracular rings black; raised, smooth, interhumeral pale line evident; length 11-13 mm. .....31. *ictericus* (Linn.)

XI. *Hymenarcys* Amyot & Serville

1. Side margins of pronotum straight or slightly concave; humeral angles subacute; length 6.5-8 mm. .....32. *aequalis* (Say)

Side margins of pronotum broadly arcuate; humeral angles broadly rounded; length 9-11 mm. .....33. *nervosa* (Say)

XII. *Menecles* Stal

1. Broadly oval, depressed; venter yellow with a median row of large black spots; humeri obtusely rounded; length 12-14 mm. .....34. *insertus* (Say)

XIII. *Prionosoma* Uhler

1. Brownish-yellow with fuscous markings and covered with a heavy pile; scutellum with a broad, Y-shaped carina; length 8.5-11 mm. .....35. *podopioides* Uhl. (Fig. 32)

XIV. *Coenus* Dallas

1. Punctures of head noticeably finer than those of pronotum; anterior angles of pronotum not toothed laterally; length 11-11.6 mm. .....36. *inermis* Harr. & John.

Punctures of head and pronotum similar; anterior angles of pronotum toothed laterally; length 8.5-10.5 mm. .....37. *delius* (Say) (Fig. 29)

XV. *Neottiglossa* Kirby

1. Head triangular, narrowed toward apex, its front not deeply concave; length 4-5 mm. .....38. *sulcifrons* Stal

Head broadly oval, its front broadly, deeply and semicircularly concave; length 4-5.2 mm. .....39. *cavifrons Stal* (Fig. 23)

XVI. *Aelia* Fabricius

1. Antennal I not reaching apex of head; lateral margins of pronotum and coria smooth and pale; length 8.5 mm. .....40. *americana* Dall. (Fig. 30)

XVII. *Cosmopepla* Stal

1. Black, interhumeral markings and spot on either side of scutellum near apex red or yellow; length 5-7 mm. .....41. *bimaculata* (Thom.)

XVIII. *Murgantia* Stal

1. Antennae shorter than pronotum and scutellum together; pronotum with anterior angles rounded; length 5.5-6.5 mm. .....42. *histrionica* (Hahn) (Fig. 34)

XIX. *Acrosternum* Fieber

1. Side margins of pronotum distinctly arcuate; jugae slightly exceeding tylus; form broadly oval; length 13.5-15 mm. .....43. *pennsylvanicum* (DeG.)

Side margins of pronotum straight or nearly so; jugae equalling tylus; form elongate-oval; length 13-19 mm. .....44. *hilare* (Say)

XX. *Banasa* Stal

1. Pronotum with anterior two-thirds green or olivaceous, sharply contrasting with posterior portion which is reddish-brown ... 2

Pronotum without any sharply contrasting color divisions ... 3

2.(1). Antennal II not more than one-half as long as III; ventrals without black spots at lateral angles; length 8-11 mm. ... 45 *dimidiata* (Say)

Antennal II three-fourths as long as III; ventrals with black spots at lateral angles; length 11.5-12 mm. ... 46. *calva* (Say)

3.(1). Antennal II three-fourths length of III; basal angles of scutellum with a small spot or none; length 10-11.5 mm. ... 47. *sordida* (Uhler)

Antennal II not shorter than III; basal angles of scutellum with a large, pale smooth spot; length 9-11 mm. ... 48. *euchlora* Stal

XXI. *Dendrocoris* Bergroth

1. Pronotum with humeri prominent, side margins angulately concave; length 6.5-7.5 mm. ... 49. *humeralis* (Uhl.)

XXII. *Stiretrus* Laporte

1. Scutellum yellow with a large irregular spot, furcate behind reaching from base to apical fourth; length 8-10 mm. ... 50. *fimbriatus* (Say) (Fig. 35)

XXIII. *Perillus* Stal

1. Pronotum with anterior black bar not interrupted medially; femoral spine tuberculate, no longer than wide; length 5-7.5 mm. ... 51. *exaptus* (Say)

Pronotum with anterior black bar interrupted medially; femoral spine longer than wide ... 2

2.(1). Venter with submarginal row of dark spots; length 8.5-11.5 mm. ... 3

Venter without submarginal spots; length 9-11 mm. ... 53. *circumcinctus* Stal

3.(2). Shining black and red; coria black with red costa ... 52. *bioculatus* (Fab.)

Brown or piceous and ivory-white or pale yellow; coria ivory-white with inner margin and discal spot black ... 52a. *b. clanda* (Say)

XXIV. *Mineus* Stal

1. Blue-black, marked with orange red as follows: edge of head, margins and median line of pronotum, basal half of costa, free edges of scutellum and margins of connexiva; length 9-10 mm. ... 54. *strigipes* (H-S)

XXV. *Apateticus* Dallas

1. Humeral angles acute; connexivum narrowly or not exposed; length 15-20 mm. ... 55. *cynicus* (Say)

XXVI. *Podisus* Herrick-Schaeffer

1. Humeri produced outward in slender, simple spines; hind femora with two blackish dots at apical third; membrane with a short, fuscous, subapical blotch; length 11-13.5 mm. ... 56. *maculiventris* (Say) (Fig. 36)

Humeri obtusely angled or rounded, without projecting spines; hind femora ringed or immaculate at apical third ... 2

2.(1). Femora thickly flecked with purplish dots and with a subapical ring of the same; side margins of head in front of eyes pale; length 9.5-11.5 mm. ... 57. *serieventris* Uhl.

Femora immaculate or nearly so; side margins of head in front of eyes black; length 7.5-9 mm. ... 58. *placidus* Uhl.

KEYS TO THE MISSOURI TRIBES, GENERA AND SPECIES OF CYDNIDAE

1. Anterior tibiae compressed; tibiae with close-set, stout spines; never with white margins on pronotum and coria ..... *Cydnini* 2
   Anterior tibiae not compressed; tibiae with scattered spines; side margins of pronotum and costal borders of coria white ..... *Sehirini*; VII. *Sehirus*
2.(1). Coria not meeting behind tip of scutellum 3
   Coria meeting behind tip of scutellum ..... VI. *Amnestus*
3.(2). Hind tibiae strongly flattened and curved, with long bristles below and stout spines above ..... I. *Cyrtomenus*
   Hind tibiae cylindrical, slender and straight, uniformly spined above and below 4
4.(3). Pronotum with impressed line just behind front margin ..... II. *Pangaeus*
   Pronotum without impressed line behind front margin 5
5.(4). Sides of body not fringed with cilia or spines; head without a bristle bearing groove just within reflexed margin ..... III. *Geotomus*
   Sides of body fringed with evident cilia or spines; head with a deep groove just within the reflexed margin, this bearing numerous irregular bristles and teeth 6
6.(5). Jugae slightly surpassing apex of tylus; membrane without evident venation ..... IV. *Cydnus*
   Jugae just equalling tylus; membrane with evident venation ..... V. *Aethus*

I. *Cyrtomenus* Amyot & Serville

1. Very convex above and beneath; color dark chestnut-red; antennal II distinctly shorter than III; length 6.5-8 mm. ..... 59. *mirabilis* (Perty)

II. *Pangaeus* Stal

1. Antennals II and III subequal; impressed line near front margin of pronotum entire; length 6.5-8 mm. ..... 60. *bilineatus* (Say) (Fig. 25)
   Antennal II distinctly longer than III; impressed line of pronotum represented medially by coarse punctures; length 6.5-8 mm. ..... 61. *discrepans* (Uhl.)

III. *Geotomus* Mulsant & Rey

1. Head and scutellum distinctly punctate; body black; length 3.8-4.2 mm. ..... 62. *robustus* (Uhl.)

IV. *Cydnus* Fabricius

1. Chestnut-brown, membrane milky-white; apex of scutellum broadly rounded; 4-4.5 mm. ..... 63. *obliquus* (Uhl.)

V. *Aethus* Dallas

1. Antennal II distinctly longer than III; beak slightly surpassing middle coxae; length 6-7.5 mm. ..... 64. *communis* Uhl.

VI. *Amnestus* Dallas

1. Uniform dark chestnut-brown; length 3.2-4 mm. ..... 65. *spinifrons* (Say)
   Color in part or wholly pale yellowish- or reddish-brown; length less than 2.7 mm. 2
2.(1) Jugae each with five submarginal spines; length 2.2-2.7 mm. ..... 66. *pallidus* Zimm.
   Jugae each with four submarginal spines; length 2-2.5 mm. ..... 67. *pusillus* Uhl.

VII. *Sehirus* Amyot & Serville

1. Antennal II and line on outer side of tibiae white; jugae not meeting in front of tylus; length 4-7 mm. ..... 68. *cinctus* (Beauv.) (Fig. 26)

KEYS TO THE MISSOURI GENERA AND SPECIES OF THYREOCORIDAE

1. Sides of pronotum and costal margins of coria ciliate with long slender bristles ..... I. *Cydnoides*

Sides of pronotum and coria without bristles 2

2.(1). Costal margins of coria black and bordered within by a distinct groove..... II. *Galgupha*

Costal margins of coria at least in part pale yellow or white and never with an inner bordering groove ..... III. *Allocoris*

I. *Cydnoides* Malloch

1. Corium entirely black or fuscous, rounded at apex; length 4-5.2 mm..... 69. *ciliatus* Uhl.

II. *Galgupha* Amyot & Serville

1. Front tibiae with antero-dorsal row of spines terminated apically by two weak setulae 2

Front tibiae with antero-dorsal row of spines not terminated apically by two weak setulae 3

2.(1). Outline, when viewed from above, noticeably narrower posteriorly than anteriorly; length 4.5-6 mm. ..... 73. *carinata* McA. & Mall. (Fig. 27)

Outline, when viewed from above, very little narrowed posteriorly; length 4.5-6 mm. ..... 72. *atra* A&S

3.(1). Lateral area of metapleurum distinctly punctured adjacent to the ostiolar area; length 4-4.5 mm. ..... 74. *nitiduloides* (Wolff)

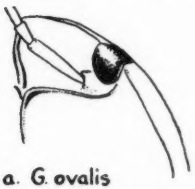
Lateral area of metapleurum not so punctured 4

4.(3). Scutellum, when viewed from side, not abruptly declivitous beyond middle (Fig. 15) 5

Scutellum, when viewed from side, abruptly declivitous beyond middle (Fig. 17); length 4-5 mm. ..... 71. *aterrima* Mall.

5.(4). Prosternum with anterior margin below each eye not produced into a lobe and not with a marginal band of minute tubercles (Fig. a); length 4.5-5 mm. ..... 70. *ovalis* Hussey

Prosternum with anterior margin below each eye produced into an explanate lobe, which has a broad marginal band of minute tubercles anteriorly and ventrally (Fig. b); length 3.5-5.2 mm. ..... 70½ *loboprostethia* Sail.



a. G. ovalis

b. G. loboprostethia

III. *Allocoris* McAtee & Malloch

1. Pale costal margin of corium widened basally so as to cross subcostal nervure onto disk of corium; postero-dorsal face of hind tibia with three or four spines; length 2.7-3.2 mm. ....77. *pulicaria* (Germ.) (Fig. 24)

Pale costal margin not widened basally so as to cross subcostal nervure..... 2

2.(1). Apex of corium obtuse; length 3.2-4.5 mm. ..... 75. *gillettii* McA. & Mall.

Apex of corium acute 3

3.(2). Postero-dorsal face of hind tibia with three or four spines; length 2-3 mm. .....76. *marginella* (Dall.)

Postero-dorsal face of hind tibia without spines 4

4.(3). Pale costal margins of corium with inner margin slightly angulated near middle; length 3-4 mm. .....78. *agrella* McA.

Pale costal margin of corium with inner margin straight; length 2.5 mm..... .....79. *harti* Mall.

Annotated List of Species

Scutelleridae

1. *Stethaulax marmoratus* (Say). Numerous specimens collected from *Rhus aromatica* and *R. canadensis* on a wooded hillside near Eminence (Shannon County) on May 20, 1939 (EH and RCF) and again on June 16, 1940 (EH).

2. *Homaemus aeneifrons* (Say). This species is listed for Illinois and Nebraska and will possibly be found in the northern portion of Missouri. It apparently prefers grasses and other plants near marshy places.

3. *Homaeus bijugis* Uhler. This is another possible species. It has been listed for Illinois, Iowa, Nebraska and Kansas.

4. *Homaemus parvulus* (Germ.). Several specimens swept from field of timothy, weeds bordering woods and along stream banks. It should be found throughout the state. Adults have been collected from June 2 to August 18. Boone, Henry, Phelps, Ste. Genevieve, Schuyler, Stoddard (CW).

5. *Phimodera binotata* (Say). Recorded from central Illinois and Nebraska, this species should be found in at least the northern section of our state.

6. *Eurygaster alternata* (Say). This very widely spread species may be looked for in Missouri. It is usually found among grasses or sedges in moist areas.

7. *Camirus porosus* (Germ.). This apparently rare little species is represented in local collections by two Missouri specimens. One was taken in the Japanese Beetle Traps in St. Louis. The other was collected from under a rock on a wooded hillside at Devil's Elbow (Pulaski County) on March 10, 1940. The latter specimen was taken in company with the two species of *Hymenarcys*, all three apparently hibernating together.

8. *Acantholoma denticulata* Stal. Listed for Iowa, Illinois and Kansas, this species will undoubtedly be found in Missouri. Harris and Andre (1934) give some very interesting notes on the biology of this species. They record its host plants as being *Ceanothus pubescens* and *C. ovatus*.

Podopidae

9. *Podops cinctipes* Say. A scarce species that is to be found in low marshy areas or among weeds bordering bodies of water. Boone X-16 (WSC), St. Charles V-29, St. Louis VI-16 (JBTraps).

10. *Podops parvulus* Van D. As yet, no Missouri records are available for this species. It has, however, been listed for Illinois and Kansas and might be found in this state.

PENTATOMIDAE

11. *Mecidea longula* Stal. A single specimen of this elongate pentatomid was taken at lights in Columbia (Boone County) on October 5, 1937.

12. *Brochymena arborea* (Say). This locally uncommon species was originally described from Missouri. Available specimens were collected in April and September. Boone, Crawford, Johnson (MSTC), St. Louis, Wayne.

13. *Bryochymena quadripustulata* (Fab.). This very common species is found throughout the state. Adults have been taken during every month of the year, in winter under bark and in summer feeding on *Quercus, Salix* and *Ulmus*. Nymphs have been observed from June until August feeding on the above mentioned trees. Adults may hibernate singly or in small groups. Barry, Boone, Buchanan (CMG), Callaway, Cape Girardeau (CW), Crawford, Franklin, Howell (SDA), Jasper (CA), Johnson (MSTC), Marion (SDA), Morgan, Oregon (EH), Pemiscot (HEB), Pettis (WRE), Pike (WSC), Randolph, St. Charles, St. Louis, Saline (SDA), Taney (EH).

14. *Brochymena cariosa* Stal. This species should be found commonly throughout at least the Ozark section of the state. Like *quadripustulata* it hibernates under bark and in logs, but congregates in larger numbers, one such group yielding twenty-nine specimens. So far records for adults are from November 5 to April 16. Cole, Crawford, Jefferson, McDonald, Miller, Oregon, Osage, Phelps, Pulaski, Ste. Genevieve.

15. *Brochymena* spec. The single specimen representing this species is a female that was collected from an oak leaf near Rolla (Phelps County) on July 13, 1940. Mr. Herbert Ruckes of New York, to whom the specimen was submitted for identification, states that although it is very close to *B. punctata*, it probably represents a new species. We are both of the opinion that it should not be described as a new species until a larger series is at hand.

16. *Peribalus limbolarius* Stal. This, our second most common species of the family, is to be found throughout the state. Adults have been collected during every month of the year, but most commonly in fall. The winter is passed under mullein leaves, in grass clumps and in other protected places. Adults have been observed feeding on *Solidago* and *Polygonum*. Sometimes cultivated crops, such as cabbage and various melon vines, are injured. Boone, Buchanan (SDA), Carter, Caldwell, Crawford, Franklin, Jefferson, Johnson (MSTC), Lawrence (WWS), Newton (SDA), Oregon, Pemiscot (EH), Perry, Phelps, Pike, Pulaski, St. Charles, St. Louis, Wayne.

17. *Trichopepla semivittata* (Say). This not uncommon species seems to prefer to stay on low plants in weedy fields, seldom being taken more than eighteen inches above the ground. Mature nymphs have been collected as late

as the first of November. Records show this species as adult from mid April until late November; more collecting, however, should show this species hibernating as adults. Boone, Franklin, Henry, Iron, Lawrence (WWS), New Madrid, Pettis (WRE), Pulaski, St. Louis, Taney, Wayne, Worth (RIW).

18. *Chlorochroa uhleri* Stal. A scarce species that has been collected from May through October. One specimen was swept from *Melilotus*. Boone, Buchanan (SDA), St. Louis.

19. *Chlorochroa sayi* Stal. A single specimen of this species from the University collection bears the label "Columbia, Mo. Sept. 190-."

20. *Thyanta calceata* (Say). A scarce species that has been collected in Missouri from April until October. Most specimens have been swept from Ozark Woods. Carter, Crawford, Jackson (SDA), Phelps (EH), Pulaski (WRE), Shannon (EH).

21. *Thyanta custator* (Fab.). This, the commonest pentatomid in Missouri, is found during every month of the year and should occur throughout the state. Adults hibernate in grass clumps and under mullein leaves. The color of this species varies from gray with black flecks through wholly green to green with purple or reddish markings. VanDuzee (1917) records this species correctly for Missouri. Bollinger, Boone, Buchanan, Butler (SDA), Caldwell, Callaway (WRE), Carter, Cole, Crawford, Dunklin, Franklin (SDA), Henry, Howard (WRE), Jackson (SDA), Jefferson, Johnson (MSTC), Lawrence (WWS), Maries (EH), Miller (DD), Mississippi (SDA), Morgan (WRE), Newton (SDA), Oregon, Ozark (SDA), Pemiscot, Pettis (WRE), Phelps, Pike, Polk, Pulaski, St. Charles, St. Louis, Shannon, Taney, Texas (EH), Vernon (WRE), Washington.

22. *Thyanta rugulosa* (Say). The only Missouri specimen seen for this species was one taken by Mr. W. R. Enns near Metz (Vernon County) on April 21, 1940.

23. *Mormidea lugens* Fab. This common species will undoubtedly be found throughout the state. Adults have been taken during every month of the year. Nymphs have been found during June, July and August. Barry, Boone, Butler, Caldwell, Callaway (WRE), Cape Girardeau (CW), Carter, Cass, Crawford, Dunklin, Iron, Jefferson, Johnson (MSTC), Lawrence (WWS), Maries (EH), Miller (DD), Mississippi, Pemiscot, Pettis (WRE), Phelps (EH), Pike, Polk, Randolph, Ste. Genevieve, St. Louis, Saline, Schuyler, Shannon, Wayne.

24. *Solubea pugnax* (Fab.). This species is very common in the southern counties, less so in the northern ones. Adults can be found the year around, hibernating principally in grass clumps. Nymphs have been taken in August, September and October. This is apparently a grass-feeding species, nymphs and adults being found feeding on *Setaria* in the southern part of the state. Adults have been collected off of numerous other plants, but no feeding was observed. Barry, Boone, Butler, Callaway (WRE), Dunklin, Dade, Lawrence

(WWS), Madison, Mississippi, New Madrid (SDA), Newton (CA), Pemiscot, Polk, St. Louis, Shannon, Wayne.

25. *Proxys punctulatus* (Beauv.). Four specimens were taken in the Japanese Beetle traps in St. Louis on the following dates: July 8 and 21; August 8 and 21.

26. *Euschistus servus* (Say). A common species of which adults have been collected from late April until early October. It feeds on a long list of native plants and some cultivated ones. The plant on which it is found feeding in both adult and nymphal stages most often is *Verbascum*. Barry, Boone, Buchanan, Butler, Cole (SDA), Dunklin, Franklin, Iron, Jackson (SDA), Lawrence (WWS), McDonald, Madison, Miller (DD), Mississippi (SDA), Morgan, Newton (SDA), Pemiscot, Pike, Pulaski, St. Charles, Ste. Genevieve, St. Louis, Taney.

27. *Euschistus euschistoides* (Voll.). A common species that seems to grade into *servus*. All the specimens with the jugae distinctly surpassing the tylus are here considered as *euschitoides*. However, this character, plus the color of the antennae and the degree of exposure of the connexivum all vary so much that it is difficult to draw a line separating this species and *servus*. As separated above, this species has been found as adults during every month of the year, hibernating beneath mullein leaves and in grass clumps. Adults have been observed feeding on *Verbascum*, but like *servus*, many specimens were seen on numerous other plants. Boone, Buchanan (SDA), Butler, Cape Girardeau (CW), Crawford, Franklin, Jackson, Johnson (MSTC), Lawrence (WWS), Madison, Mississippi, Pemiscot, Pulaski, Ste. Genevieve, St. Louis, Shannon (EH), Wayne.

28. *Euschistus politus* Uhl. Of the three available Missouri specimens, two were swept from open woods in the Ozark section of the state, the other was taken in the Japanese Beetle Traps in St. Louis. Iron VII-23, Pulaski X-22 (EH), St. Louis VII-8.

29. *Euschistus tristigmus* (Say). An uncommon species. This, the nominal form, is a member of the Upper Austral Life Zone. Adults and nymphs have been found feeding on *Ambrosia*. Imagoes have been collected during every month of the year. Boone (EH), Buchanan (SDA), Dunklin, Howell (SDA), Oregon, Pemiscot, Pettis (WRE), Pulaski, St. Louis, Shannon.

29a. *Euschistus tristigmus pyrrhocerus* (H-S). This subspecies is supposed to be a member of the Lower Austral Life Zone but is found abundantly as far north as St. Louis and Kansas City. Adults have been collected in June, July, August and October feeding on *Quercus* and blackberries. This form is correctly listed for the state by VanDuzee in his "Catalogue" (1917). Butler, Caldwell, Dunklin, Jackson (SDA), Mississippi (SDA), New Madrid (SDA), St. Louis.

30. *Euschistus variolarius* (Beauv.). A very common species the year around, hibernating as adults under leaves and in grass clumps. This species has been taken from many plants including *Ambrosia*, *Medicago*, *Populus*,

Vernonia, Asclepias, Polygonum and *Solidago*. Say described his synonym of this species, *Pentatoma punctipes*, from Missouri and Pennsylvania. Boone, Buchanan (SDA), Butler, Caldwell, Callaway (WRE), Cole, Crawford, Dade, Dunklin (EH), Franklin, Greene (SDA), Jackson (SDA), Jasper (CA), Jefferson, Iron, Lafayette, McDonald, Miller (DD), Mississippi, Morgan (WRE), Newton (SDA), Nodaway, Pettis (WRE), Pike, Pulaski, St. Charles, Ste. Genevieve, St. Louis, Saline, Stoddard, Washington, Wayne.

31. *Euschistus ictericus* (Linn.). But four specimens from the state were seen. Two were taken from the Japanese Beetle Traps in St. Louis, the other two were collected from *Salix* at the edges of bodies of water. St. Charles V-7, St. Louis VII-18 & VIII-2 (JBTraps), VII-21.

32. *Hymenarcys aequalis* (Say). A not common species taken from February through October. The February specimens were taken from under the loose bark on a standing tree. The others were swept from weedy fields. Boone, Butler, Crawford, Pulaski, St. Louis (EPM), Taney.

33. *Hymenarcys nervosa* (Say). One of the less common pentatomids of the state. Adults are apparently to be found the year around as they have been taken from grass clumps and under rocks and mullein leaves in winter and have been swept from weedy growths during summer and fall. Barry, Boone, Callaway (WRE), Crawford, Jefferson, Lawrence (WWS), McDonald, Madison, Pulaski, St. Louis, Shannon, Stone.

34. *Menecles insertus* (Say). A not uncommon species found most frequently in various oak associations. One was seen with its beak imbedded in the trunk of a young Elm. Adults have been collected during every month of the year. Say originally described this species as *Pentatoma insertus* from Arkansas and Missouri. Van Duzee records it correctly for Missouri in his "Catalogue" (1917). Boone, Callaway (WRE), Crawford, Lafayette, St. Louis, Washington (WRE).

35. *Prionosoma podopioides* Uhl. A scarce species that will undoubtedly be found throughout the state. Adults have been taken in July, August, September, and December. The winter record is from a specimen taken from beneath bark on a dead tree. The other records are all from fields or open woods where the Large Bracted Plantain, *Plantago aristata*, was common. Boone, Jackson, Ste. Genevieve, St. Louis.

36. *Coenus inermis* Harr. & John. This recently described species was named in part from specimens taken in Marion County, Arkansas, which is adjacent to Ozark and Taney Counties in Missouri. Accordingly, we may look for this species in the south central part of the state.

37. *Coenus delius* (Say). Say's types were from Missouri and Massachusetts. Locally a scarce species that has been swept from *Solidago* in weedy field. Adults have been collected in June, July, August, September and February. Boone (HEB), Caldwell, Jackson, St. Louis.

38. *Neottiglossa sulcifrons* Stal. A fairly common species which has been swept from dry weedy fields and open woods. Adults occur the year around,

hibernating in grass clumps. Both this species and the next are often found together. Adair (EH), Boone, Cole, Dunklin, Lafayette, Nodaway, Schuyler, Shelby, St. Charles, St. Louis, Saline (EH).

39. *Neottiglossa cavifrons* Stal. This species is often found with the preceding one, but is a little bit more numerous. Adults have been collected during every month of the year. Boone (AGP), Butler, Cole, Dade, Lincoln, Pike, St. Charles, St. Louis, Shelby.

40. *Aelia americana* Dall. This apparently scarce western species should occur throughout the state. Mr. W. R. Enns says that he has taken it commonly from apple trees in orchards. Other specimens have been found hibernating in grass clumps and under mullein leaves. Adults have been collected during April, May, July, August, November and December. Boone, Cape Girardeau (CW), Cass, Lawrence (WWS), Macon (WRE), Mississippi, Perry, St. Louis, Saline.

41. *Cosmopepla bimaculata* (Thom.). An uncommon species that is usually swept from weeds along streams. It should be found throughout the state. Adults have been collected from mid-April until the early part of September. It was recorded from Missouri by Van Duzee in 1917. Buchanan, St. Louis.

42. *Murgantia histrionica* (Hahn). This is the well-known Harlequin Cabbage-bug or Calico -back-bug which is such a serious pest of cabbages. Adults have been collected from April 4 to the middle of September. Van-Duzee (1917) lists it for Missouri. Barry, Boone (AGP), Butler (SDA), Callaway (SDA), Cole (SDA), Jasper (SDA), Jefferson, Johnson (MSTC), Lawrence (WWS), Saline (SDA), St. Louis (EPM), Vernon (WRE).

43. *Acrosternum pennsylvanicum* (DeG.). This is a rare species in Missouri. The only from the state that was seen was collected by Miss Elsie Herbold while sweeping weeds in an over-grown orchard near Eminence (Shannon County) on June 16, 1940.

44. *Acrosternum hilare* (Say). Originally described from Missouri as a member of the genus *Pentatoma*. A not uncommon species that is a strong flier and should be found throughout the state. Records show adults on the wing from late April through September. Mature nymphs have been found in September. On August 22 adults were observed mating and feeding on asparagus. Barry (SDA), Boone, Buchanan (SDA), Crawford, Lawrence (WWS), Osage, St. Louis, Shannon, Taney, Wayne.

45. *Banasa dimidiata* (Say). The two available Missouri specimens of this species were taken in the Japanese Beetle Traps in St. Louis on July 10 and August 14. This species should be found throughout the state.

46. *Banasa calva* (Say). This species has been listed for Illinois, Colorado and other states and so may be looked for in Missouri.

47. *Banasa sordida* Uhl. This species has been collected just across the Mississippi River at Grand Tower, Illinois and so should be found in Missouri.

48. *Banasa euchlora* Stal. This southern species that ranges as far north as Illinois and Iowa should be found in Missouri.

49. *Dendrocoris humeralis* (Uhl). A scarce species in Missouri. All specimens collected by the author were taken from oak trees. All male specimens that I have seen from the state lack any indication of the spine on the second ventral segment. This spine is present and distinct in the females. So that this may not confuse the user of the key, the genus is placed under both forms, those with and those without the spine on the second ventral. Specimens have been collected in May, June and July. Butler, Callaway (WRE), Crawford, Maries (EH), St. Louis, Stoddard.

50. *Stiretrus fimbriatus* (Say). A relatively scarce species that should be found throughout the state. It is commonly known as the "Bordered Soldier-Bug." Adults have been collected from May until September. Nymphs have been collected in August. Boone (WSC), Buchanan (SDA), Cass, Cole, St. Louis, Saline.

51. *Perillus exaptus* (Say). A single specimen was swept from a weedy field in St. Louis on July 2, 1935. Missouri is listed as the type locality. Uhler (1861) lists this species for the state as a member of the genus *Zicrona*. VanDuzee (1917) and Blatchley (1926) both list it correctly for this state.

52. *Perillus bioculatus* (Fab.). A scarce species in this state. The only four specimens located bear the following data: St. Louis V-11-34 (EPM), Ranken XI-31 (EPM3 and St. Louis XII-12-36.

52a. *Perillus bioculatus clanda* (Say). A single specimen of this form was collected by Dr. E. P. Meiners in St. Louis on June 11, 1934.

53. *Perillus circumcinctus* Stal. Recorded from Missouri without definite locality by VanDuzee (1917) and again by Blatchley (1926). It should occur throughout the state.

54. *Mineus strigipes* H-S. Three Missouri specimens were available: one from *Asclepias* in St. Louis VII-24-35, one in the Japanese Beetle Traps in St. Louis and one in Shannon County VI-16-40 (EH).

55. *Apateticus cynicus* (Say). This large, uncommon species which was originally described from Missouri as a member of the genus *Pentatoma* is usually found under bark. The few available records indicate that adults occur in June and July. It has been listed correctly for the state by VanDuzee in 1917. St. Louis, Crawford.

56. *Podisus maculiventris* (Say). The "Spined Soldier-Bug" that occurs commonly from April through October and is found throughout the state. Adults have been observed feeding on many lepidopterous larvae as well as the grubs of *Lema trilineata*. Nymphs, which also are predaceous, have been found in July and August. Barry (SDA), Bollinger, Boone, Buchanan, Callaway (WRE), Cape Girardeau (CW), Cole (SDA), Crawford, Dunklin, Franklin, Jackson (SDA), Jasper (CA), Lawrence (WWS), Mississippi, Morgan, Newton (SDA), Nodaway, Osage (SDA), Pemiscot, Pettis (WRE),

Phelps, Pike (SDA), Pulaski, Randolph, Ray (SDA), Ste. Genevieve, St. Louis, Shannon, Schuyler, Washington (WRE).

57. *Podisus serieventris* Uhl. This species is represented by a single Missouri specimen collected by Dr. E. P. Meiners in St. Louis County on October 10, 1937.

58. *Podisus placidus* Uhl. Another rare species, the only Missouri record being that of Miss Elsie Herbold for Big Spring State Park (Carter County) on June 30, 1940.

CYDNIDAE

59. *Cyrtomenus mirabilis* (Perty). A southern species for which the present records seem to be a northern limit of range. It has been taken at lights during July (EPM), August (EPM), and September. Jefferson (EPM), St. Louis.

60. *Pangaeus bilineatus* (Say). This species, originally described from Pennsylvania and Missouri, was taken in enormous numbers in the Japanese Beetle Traps in St. Louis. Records from other than this source are very few. Adults are to be found from May through September. Carter (EH), Callaway (WRE), Jasper (——), Perry, Pike (SDA), Polk, St. Louis.

61. *Pangaeus discrepans* Uhl. Since this species is listed for Indiana, Tennessee and Colorado it may be looked for in Missouri.

62. *Geotomus robusta* (Uhl.). Only three Missouri records of this scarce little species are available. Barton I-3 (WSC), Boone VI-8 (AGP), Scott VI-20.

63. *Cydnus obliquus* (Uhl.). A single specimen taken in the Japanese Beetle Traps in St. Louis on June 22 comprises the only available Missouri record for this apparently rare little species.

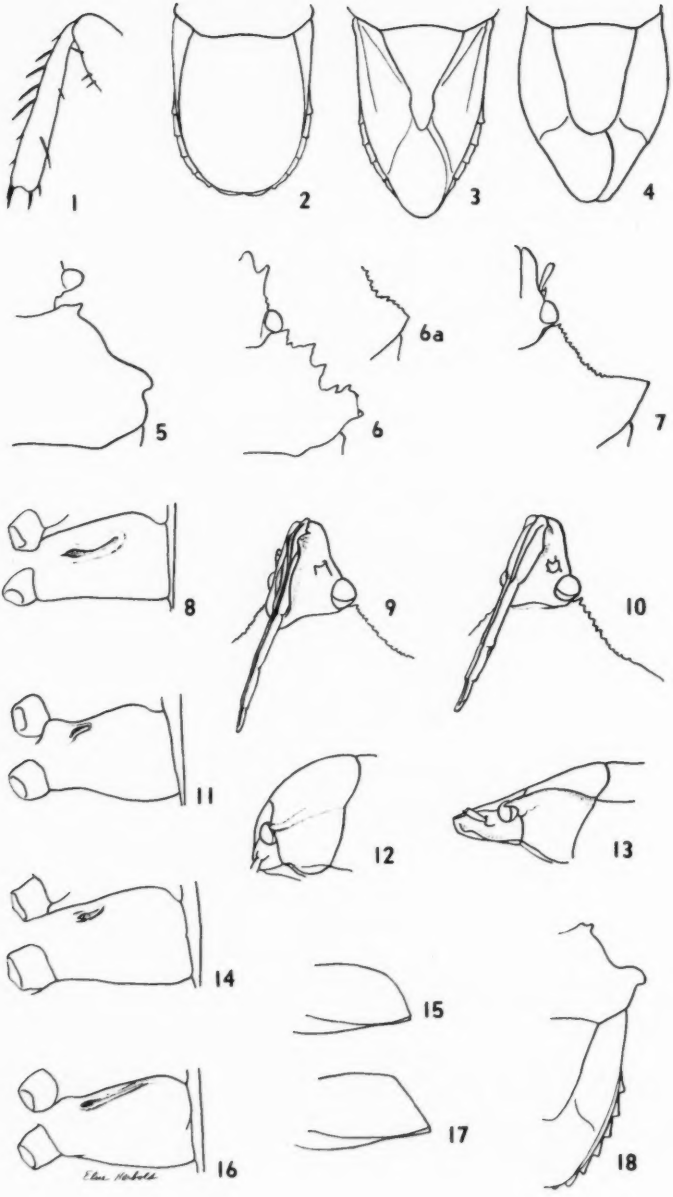
64. *Aethus communis* Uhl. A rare form known from Florida, Indiana and Texas, this species might be found in the southern part of the state.

65. *Amnestus spinifrons* (Say). Say's type for his *Cydnus spinifrons* was from Missouri. I have seen no Missouri specimens of this species, but since it is listed for Illinois, Iowa, Nebraska, Texas and Florida it should be found throughout this state.

66. *Amnestus pallidus* Zimm. This species was described from Kansas and has been listed for Illinois so we may expect it in Missouri.

67. *Amnestus pusillus* Uhl. All specimens from which the present data were taken had been captured at lights. Records of adults are from May 8 to September 6, but the adults undoubtedly hibernate here as they do in other states.

68. *Sehirus cinctus* (Beauv.) A not uncommon species that is found throughout the state. It is most frequent from May through August on blackberries, *Solidago* and *Helianthus*. Boone, Buchanan (CMG), Callaway (WRE), Cooper (WRE), Jasper (CA), Mississippi, Pemiscot, Pike (SDA), Polk, St. Charles, St. Louis.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THYREOCORIDAE

69. *Cydnoides ciliatus* Uhl. No specimens are to be found in local available collections, but McAtee and Malloch (1933) record the subspecific form, *crientis* McA & Mall., from the state. The typical form of this species is apparently restricted to the far western portions of the United States and Mexico.

70. *Galgupha ovalis* Hussey. So far as records are concerned, this is the commonest member of the genus in the state. It occurs as adult the year around, being found in weedy fields and among edge growth during the warmer seasons and hibernating under rocks, mullein leaves and logs during the winter. Benton (WRE), Boone, Callaway (WRE), Clark (——), Dunklin, Lafayette, Lawrence (WWS), Madison, Miller (DD), Mississippi, Montgomery, New Madrid, Pike (WSC), Polk, Pulaski, St. Charles, St. Louis, Stoddard, Vernon (WRE).

70½. *Galgupha loboprostethia* Sail. Mr. H. G. Barber has kindly called my attention to this species which was first described, in part from Missouri, several months ago by R. I. Sailer (40). The following Missouri data is noted among his paratypes: Scott Co., Mo.; Atherton, Mo.; Greene Co., Mo. In addition, specimens are at hand for Glencoe, Mo. V-16 & VII-25 and St. Peters, Mo. V-29.

71. *Galgupha aterrima* Mall. A not uncommon species that should be found throughout the state. Specimens have been taken by sweeping weedy fields. Adults have been collected from April 29 to September 12. Boone, Butler, Callaway (WRE), Carter, Dunklin (EH), Pike (SDA), St. Louis.

72. *Galgupha atra* H-S. Apparently a scarce species in this state. Specimens are available for April, May (WRE), July (WRE), and September. Hart (1919) records this species for Missouri. Boone Callaway (WRE), Lafayette, St. Louis.

73. *Galgupha carinata* McA. & Mall. This recently described species is more common than *atra*, with which it is confused in local collections. Monthly records are for May, July, August and September. Butler, Caldwell, Crawford, Dunklin, Mississippi, St. Louis (EPM).

PLATE I

Fig. 1. *Galgupha carinata*, front tibia; Fig. 2. *Stethalax marmoratus*, scutellum and coria; Fig. 3. *Euschistus variolarius*, scutellum and coria; Fig. 4. *Coenus delius*, scutellum and coria; Fig. 5. *Podops cinctipes*, lateral margins of head and pronotum; Fig. 6. *Brochymena arborea*, lateral margins of head and pronotum; Fig. 6a. *Brochymena quadripustulata*, humeral angle; Fig. 7. *Euschistus variolarius*, lateral margins of head and pronotum; Fig. 8. *Stethoulax marmoratus*, metasternal plate with ostiole; Fig. 9. *Euschistus variolarius*, ventral view of head and beak; Fig. 10. *Podisus maculiventris*, ventral view of head and beak; Fig. 11. *Euchistus variolarius*, metasternal plate with ostiole; Fig. 12. *Murgantia histrionica*, lateral view of head and prothorax; Fig. 13. *Menecles insertus*, lateral view of head and prothorax; Fig. 14. *Chlorochroa uhleri*, metasternal plate with ostiole; Fig. 15. *Galgupha ovalis*, lateral view of apex of scutellum; Fig. 16. *Thyanta custator*, metasternal plate with ostiole; Fig. 17. *Galgupha aterrima*, lateral view of apex of scutellum; Fig. 18. *Prionosoma podopioides*, lateral half of body.

74. *Galgupha nitiduloides* (Wolff). Two Missouri specimens of this species are available. One was taken at Licking (Texas County) on August 15, 1939, by Mr. Bert O. Brayton, Associate State Entomologist. The other was taken in the Japanese Beetle Traps in St. Louis on August 28, 1938.

75. *Allocoris gillettii* Van D. This species is commonly listed as *Corimelaena lateralis* (Fab.) in literature. In Missouri it is not uncommon and should be found throughout the state. So far, specimens have been collected from early May throughout October, being found under rocks and by sweeping weedy fields. Barry, Boone, Carter, McDonald, St. Louis, Stone.

76. *Allocoris marginella* Dall. McAtee and Malloch give the range of this species as "Rhode Island to Kansas, Florida and Texas," so it may be looked for in Missouri.

77. *Allocoris pulicaria* (Germ.). This very common species should be found throughout the state on a great variety of plants. Some of the plants from which it has been taken in this state include *Uvularia*, various species of *Asclepias* and *Polygonum* and *Rhus canadensis*. It is also commonly met with in sweeping weedy fields. Adults have been found from mid-April through September. Barry, Buchanan (CMG), Butler, Carter, Cole, Franklin (SDA), Howell, Jackson (SDA), Jasper (CA), Lafayette, Lawrence (WWS), McDonald, Madison, Maries, New Madrid, Newton (CA), Pettis (WRE), Phelps, Pike (SDA), Pulaski, St. Louis, Saline (EH), Shannon, Stoddard (EH), Stone, Texas.

78. *Allocoris agrella* McA. This species, which has been listed for Maryland, Virginia, Kentucky and Texas, might be found in this state.

79. *Allocoris harti* Mall. A single specimen of this species was collected near Steelville (Crawford County) on September 7, 1937.

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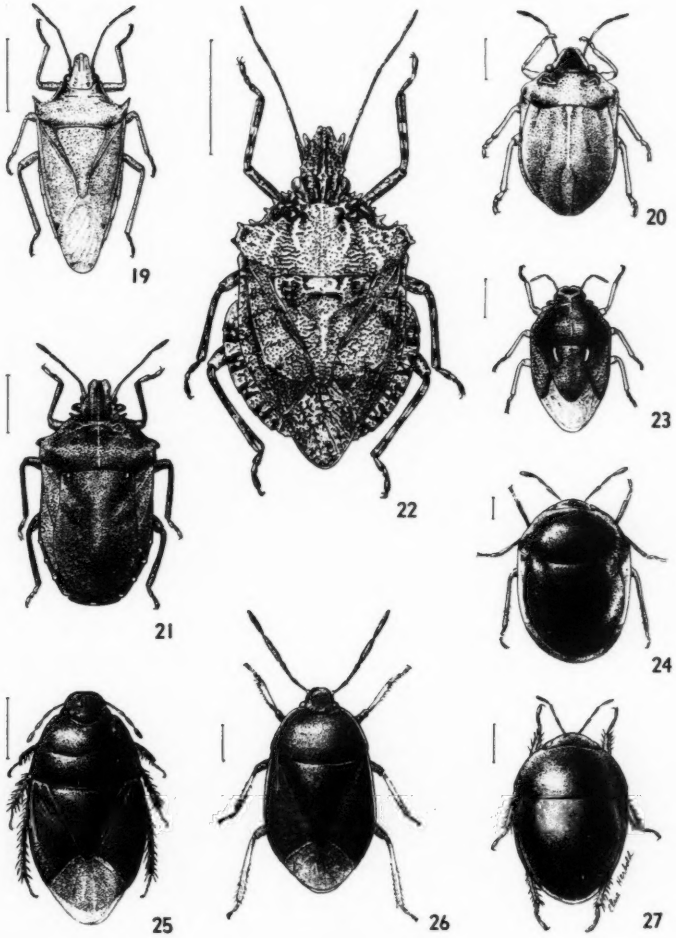


PLATE 2

Fig. 19. *Solubea pugnax;* Fig. 20. *Homaemus parvulus;* Fig. 21. *Podops cinctipes;* Fig. 22. *Brochymena arborea;* Fig. 23. *Neottiglossa cavifrons;* Fig. 24. *Allocoris pulicaria;* Fig. 25. *Pangaeus bilineatus;* Fig. 26. *Sehirus cinctus;* Fig. 27. *Galgupha carinata.*

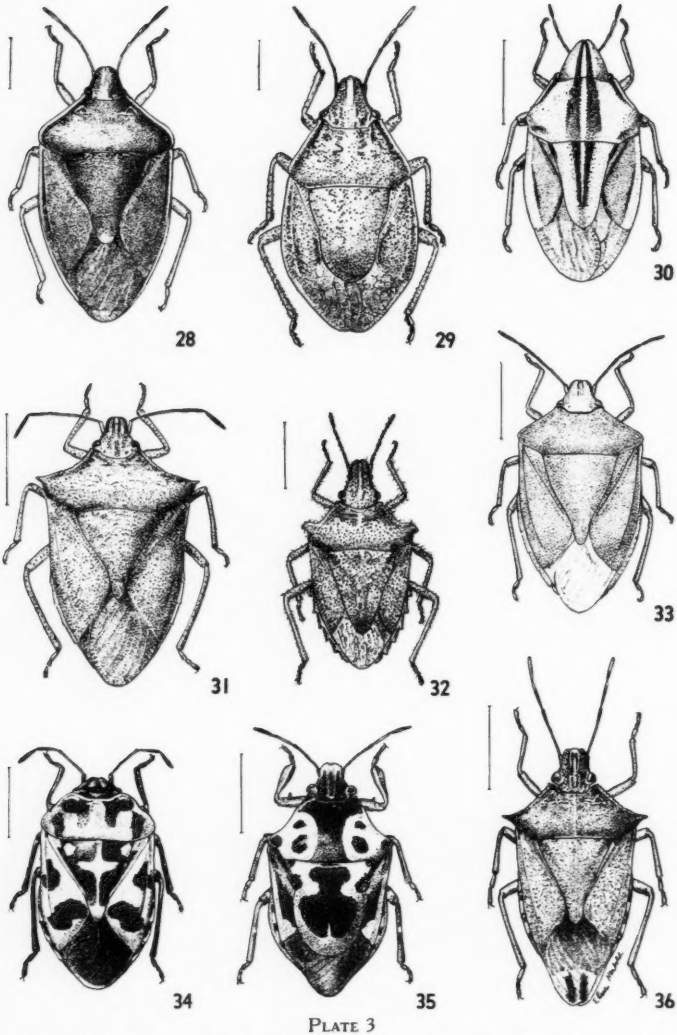


PLATE 3

Fig. 28. *Peribalus limbolarius;* Fig. 29. *Coenus delius;* Fig. 30. *Aelia americana;* Fig. 31. *Euschistus variolarius;* Fig. 32. *Prionosoma podopioides;* Fig. 33. *Thyanta custator;* Fig. 34. *Murgantia histrionica;* Fig. 35. *Stiretrus fimbriatus;* Fig. 36. *Podisus maculiventris.*

A Generic Revision of the American Osmiinae with Descriptive Notes on Old World Genera

(Hymenoptera, Megachilidae)

Charles D. Michener

In the introductory portion of her recent paper on the North American bees of the genus *Osmia*, the late Miss Grace A. Sandhouse has given a key to the American genera of the subfamily Osmiinae. This key makes use of a large number of excellent generic characteristics, many of them not previously recorded. However, evidently because of the limited amount of western material available to her, a considerable number of species cannot be properly placed with the Sandhouse key. In contrast to the seven genera considered by Sandhouse, twelve are here recognized as occurring in America. In view of this fact, it has seemed worth while to include herein a new key to the genera.

In preparing the present paper, an attempt has been made to correlate our fauna with that of the Old World so that the classification here presented could be used, by someone having adequate Eurasian and African material at hand, as a basis for a world classification of the group. About sixty Old World species, representing most of the named genera and subgenera, have been available for this work, and for specimens of these species I am indebted primarily to J. D. Alfken, G. A. Mavromoustakis, V. B. Popov, and P. H. Timberlake.

The Osmiinae may be separated somewhat arbitrarily from other groups of Megachilidae by the following combination of characters: Arolii present between the claws; second recurrent vein considerably basad to second transverse cubital; body without conspicuous integumental markings; abdominal scopa present in female.

Generic Characters

A great many diverse types are found in the Osmiinae. The Old World fauna in particular contains numerous anomalous forms which make the development of a system of classification difficult. It has seemed that almost all of the characteristics which might have been used to distinguish genera intergrade more or less completely from one group to the next with the result that an almost complete series may be found from *Chelostoma* to *Osmia*. (*Heriades* is distinctive and seems to fall outside of this series.) Furthermore, similar characteristics have evidently arisen independently in unrelated groups in some cases. In attempting to find and make use of the most stable generic characters, it has often been necessary to resort to minutiae, such as the shape of the notalices and the presence or absence of sometimes evanescent carinae on the hind coxae. These characteristics, however, which are at times difficult to understand and to see, are usually rather well correlated with other charac-

ters which are often less constant or less easily described, or with features of appearance or color. The fact, then, that much of this classification appears to be based primarily upon minute or inconspicuous differences does not, in itself, mean that the classification is unsound.

The generic characters are here presented in a comparative manner so that they may be discussed more adequately than in formal generic descriptions.

Because of interspecific variability, the shape of the clypeus is not, in general, a good generic character. In most forms it is hexagonal, somewhat broader than long, with the apical margin produced over the base of the labrum and either simple, as in most males and many females, or variously thickened, toothed, or notched. However, in the genera *Chelostoma, Prochelostoma, Formicapis, Chelostomopsis,* and *Heriades,* and in *Ashmeadiella* subgenus *Cubitognatha* the clypeus is not much produced over the base of the labrum but is shortened apically and trapezoidal. The upper margin of the clypeus is shortened in the male of *Robertsonella* so that the subantennal sutures diverge upward from the upper angles of the clypeus to the antennal scrobes. The same conformation is found to a lesser degree in the males of most *Hoplitis* and of certain other genera. The male of *Robertsonella* is distinguished from all other genera by having the lower part of the face covered with short, dense, appressed pubescence and devoid of long hairs. The labrum is variously shaped, but is usually elongate in those females with modified clypeus and mandibles. The mandibles of the males are usually rather short and bidentate, but are tridentate in *Ashmeadiella* subgenus *Chilosima* and in many species of *Anthocopa.* The mandibles of the females are much more variable, from two- to six-toothed. The maxillary palpi are short and three- to four-segmented in both *Heriades* and *Chelostoma,* four-segmented in *Prochelostoma,* longer and four-segmented in the other groups except for *Proteriades* in which the number of segments varies from two to four, *Anthocopa* in which the number varies from two to five, and *Osmia* and *Diceratosmia* in which there are five segments, the last usually small. In *Chelostoma* but in no other genera the third segment of the labial palpi is flattened and connate with the second so that there is only one small outstanding segment. In *Proteriades,* a few species of *Osmia* subgenus *Nothosmia,* and in *Anthocopa xerophila* (Cockerell) the first two sements of the labial palpi and the maxillary galeae are furnished with numerous long, stout bristles whose apices are hooked or waved. The ventral surface of the head is rather long except in some forms of *Anthocopa* (in which the horizontal, longitudinal sections of the hypostomal carinae are no longer than the transverse sections) and in some species of *Proteriades.* Certain species of *Proteriades* have the angles of the hypostomal carinae obtuse, but this is by no means a generic character.

The general shape of the thorax has been regarded as a character of great importance in this paper. In the following list the genera are arranged in a series from those with the most slender thoraces to those with the most robust. The inclusion of more than one genus in a single set of parentheses indicates that the general shape of the thorax, in genera so grouped together, is similar. *(Prochelostoma) (Chelostoma) (Heriades, Chelostomopsis) (Formicapis,*

Stenosmia) (Robertsonella) (Hoplitis) (Ashmeadiella, Proteriades, Anthocopa, Diceratosmia, Osmia). Many of the characteristics listed in the first couplet of the key are merely means of indicating the shape of the thorax; some of these are not repeated here. The notalices are punctiform in *Osmia,* and only slightly elongate in *Diceratosmia.* In all other genera they are linear, being longest in *Chelostoma* and *Prochelostoma.* The anterior as well as the posterior part of the thorax is elongated in *Chelostoma* and *Prochelostoma* in which a line between the anterior ends of the tegulae passes through the middle of the mesoscutum; in all other genera such a line passes considerably anterior to the middle. In the Osmiini and in *Formicapis* the shortest distance between the tegulae is considerably greater than the length of the mesoscutum; in the other genera it is but little greater, except for *Chelostoma* and *Prochelostoma* in which it is less. The mesoscutellum is rather flat and elongate in the Heriadini, usually more convex and short in the Osmiini. The metanotum in the Osmiini is on the posterior declivity of the thorax in such a position that its anterior margin is uppermost, while in the American Heriadini it is more or less on the dorsal surface of the thorax in such a position that its median convexity is the uppermost part seen in profile. The propodeum in *Heriades* has a horizontal basal area, set off posteriorly by a carina and traversed by several longitudinal carinae, breaking it transversely into a series of pits, but there is no triangular propodeal area as in all other genera. The anterior margin of this propodeal triangle is more or less horizontal in all the other Heriadini, and except in *Formicapis* and some *Chelostoma* it is more coarsely sculptured than the rest of the triangle. Even in many Osmiini (some representatives of most genera) the anterior portion of the propodeal triangle is more nearly horizontal than the rest, and may be more coarsely sculptured. The median pit on the posterior face of the propodeum is not greatly longer than broad and its surface is broadly concave and shining, except in *Heriades* and most *Hoplitis* in which it is quite elongate and its crosssection more or less V-shaped, and except in *Chelostoma, Prochelostoma,* and *Formicapis,* in which it is similarly elongated but dull (it is dull and granular also in at east one species of *Hoplitis*). The declivity of the propodeum is much more nearly vertical in the forms with short, robust thoraces, such as *Osmia* and *Anthocopa,* than in forms with more elongate thoraces, as *Hoplitis* and the Heriadini. Each posterior lobe of the pronotum is marked anteriorly by a subvertical carina in *Heriades, Ashmeadiella,* and *Stenosmia,* and by such a carina or an angle indicating its position in most *Anthocopa;* in other genera the contour of the lobe is rounded anteriorly. In most genera the angle between the anterior face of each mesepisternum and the lateral face is rounded· and there is a more or less gradual transition in sculpture between anterior and lateral faces; however, in *Noteriades, Ashmeadiella* and *Stenosmia* and in *Anthocopa (Hoplosmia) bidentata* (Morawitz) and *anceyi* (Pérez) a small prepectal carina separates the faces of the mesepisternum except above, and the anterior face is shining and nearly smooth while the lateral face is conspicuously punctate with no area of intergradation except on the upper parts of the mesepisterna. The anterior faces of the mesepisterna are smaller in the Heriadini than in the Osmiini. The suture separating

the mesopleura from the metapleura is evenly arcuate toward the front in *Chelostoma, Prochelostoma, Chelostomopsis, Heriades, Proteriades, Ashmeadiella,* some *Hoplitis,* and a few *Anthocopa.* It has a more or less straight median section in the other forms. The carina between the summits of the middle and posterior coxae, separating the lower metapleural areas from the propodeum, is arched in *Robertsonella* and in *Diceratosmia* (except *D. azteca* (Cresson)) but is nearly straight in other groups. Each posterior coxa in certain genera bears along its inner ventral margin a longitudinal carina, the distal end of which is directed inward so that it ends mesad to the articulation of the trochanter. In certain forms this carina is reduced to a feeble impunctate line; thus in *Anthocopa* all intergradations may be found between strong carinae and inconspicuous impunctate lines. Genera having such carinae are *Chelostoma, Heriades, Noteriades, Formicapis* (carinae reduced), *Chelostomopsis, Ashmeadiella, Stenosmia, Proteriades, Anthocopa* (carinae reduced in some), and *Diceratosmia.* The carina is absent in *Prochelostoma, Robertsonella, Hoplitis,* and *Osmia.* The pterostigma varies considerably in size, being large in the Heriadini and small in the Osmiini, although intergrading quite completely between the extremes. These variations are shown in the figures; hence a discussion of them is omitted here. The apex of the marginal cell is distinctly bent away from the margin of the wing in all genera except *Chelostoma* and *Prochelostoma.*

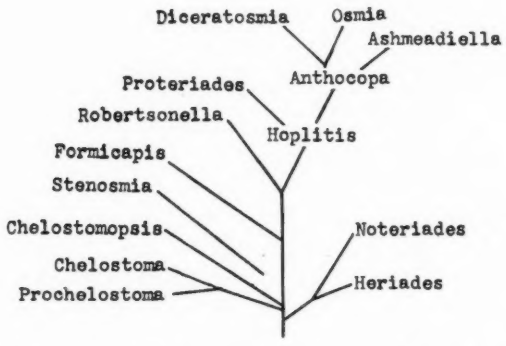
The abdomen is rather elongate and parallel-sided in the Heriadini and in *Hoplitis* (among the Heriadini it is most robust in *Robertsonella*), but is short, robust, and rounded in most other Osmiini. The anterior face of the first abdominal tergite is provided with a longitudinal median sulcus but is not separated from the dorsal surface by any line or carina in *Chelostoma, Prochelostoma, Formicapis, Robertsonella, Proteriades* (sulcus rather broad) and *Hoplitis.* In *Chelostomopsis, Stenosmia, Anthocopa, Diceratosmia,* and *Osmia* the anterior face of the first tergite is broadly but rather weakly concave, almost always separated by a feeble, transverse, impressed line or carina or weak ridge or by the abrupt termination of the often shining surface of the concavity from the horzontal dorsal surface of the tergite. In *Ashmeadiella* the concavity is slightly deeper than in the above list of genera and in *Heriades* and *Noteriades* it is margined posteriorly by a strong carina. In the forms mentioned above with rather long, parallel-sided abdomen, the dorsal surface of the first tergite, seen in profile, is usually nearly as long as the anterior face while in the forms with short abdomen, such as *Osmia, Diceratosmia,* and *Anthocopa,* the dorsal face is commonly only about one-half as long as the anterior face. In males the abdomen has seven exposed tergites and six exposed sternites, except in *Heriades, Noteriades, Chelostomopsis,* and some *Anthocopa,* in which there are but six exposed tergites and five sternites (or but two to four exposed sternites in *Heriades* and *Noteriades*). In males of *Robertsonella, Formicapis, Proteriades,* and *Hoplitis,* and in a few (chiefly Old World) species of *Anthocopa,* the posterior margin of the sixth tergite bears, at each side, a tooth which is sometimes very small. Such teeth are absent in other genera except *Ashmeadiella* in which there is in addition a

pair of longer median teeth. The seventh and eighth sternites and genitalia of the males, because of their great interspecific variability, offer few well-understood generic characters; some of those which have been observed are recorded in the key and in the discussions under the genera.

Phylogeny

On the basis of their somewhat restricted distribution (primarily the Holarctic and Ethiopian regions, absent from South America and Australia), the Osmiinae may be regarded as one of the more recent major groups of bees. In the absence of sufficient understanding of bee phylogeny generally to indicate from what particular type of bee the Megachilidae may have arisen, it has been assumed that those Osmiinae having characteristics most similar to the various short-tongued bees and the wasps were the most primitive. Using this criterion, *Chelostoma* and *Prochelostoma*, with the longest notalices found in the group, elongate thorax with the anterior part of the propodeum horizontal, and large pterostigma must most nearly approach the primitive type.

The general principles of the supposed phylogenetic development are indicated in the accompanying tentative phylogenetic tree. *Formicapis*, and especially *Robertsonella*, are in many ways similar to *Hoplitis*, and could almost as well be included in the Osmiini as in the Heriadini. The tribal division is thus seen to be largely arbitrary, and is used primarily for the sake of convenience in discussion. *Proteriades* is closely related to *Hoplitis* and is probably a derivative of the *Hoplitina* group of *Hoplitis*. The genera *Hoplitis*, *Anthocopa*, and *Osmia*, particularly the first two, are the most diverse in the subfamily, each consisting of a number of apparently diverging evolutionary lines, resulting in types within each of these genera which appear quite different from other forms included therein.



Phylogenetic tree suggesting relationships of the genera of Osmiinae. Hoplitis and the genera above it are placed in the Osmiini, the other genera constitute the Heriadini.

Systematic Treatment

Key to the American Genera of Osmiinae

Although in this key only American genera are included, such additional Old World genera as are available to me are discussed briefly in the last section of this paper. Characteristics described in parentheses in the key are supplementary and intended for verification of identifications and for use with doubtful forms.

1. Thorax elongate, mesoscutellum seen in profile but feebly convex, metanotum convex and constituting part of dorsal surface of thorax, so that, seen in profile, a line tangent to the convexities of the mesoscutum and mesoscutellum would nearly touch the metanotum; propodeum with a rather distinct, horizontal, basal zone; shortest distance between tegulae usually but little if any greater than length of mesoscutum; pterostigma well developed, conspicuously broader than distance from posterior edge of prestigma to costal margin of wing, and longer than prestigma.

   (Sides of stigma, from base to radial vein, diverging apically, margin included in marginal cell usually convex and usually as long as first abscissa of radial vein; first discoidal cell usually shorter than marginal cell; coxopodites of male genitalia distad to volsellae more or less ribbon-like, parallel sided, usually slender, frequently not converging at apices; abdomen rather elongate and cylindrical. These are small, black bees.).....Tribe Heriadini 2

... Thorax short, mesoscutellum seen in profile conspicuously convex, metanotum flattened or convex, on posterior declivity of thorax, so that, seen in profile, a line tangent to the convexities of the mesoscutellum and mesoscutum would not closely approach the metanotum, and that part of the metanotum nearest such a line is its anterior margin, not a median convexity; propodeum ordinarily entirely declivous, without a horizontal area above; shortest distance between tegulae greater than length of mesoscutum; pterostigma reduced, not much broader than distance from inner edge of prestigma to costal margin of wing and often as short as prestigma.

   (Sides of stigma basad to radial vein diverging but little apically, margin included in marginal cell rarely convex, almost always shorter than first abscissa of radial vein; first discoidal cell usually longer than marginal cell; coxopodites of male genitalia distad to volsellae rarely parallel sided, usually somewhat swollen and bent inward subapically, less commonly tapering throughout and bent inward subapically; abdomen usually short and broad, although sometimes cylindrical. These are small to large bees, sometimes entirely black, sometimes marked with red, ours most commonly more or less metallic.).....Tribe Osmiini 7

2. First abdominal tergite with anterior face consisting of a large concavity, separated from dorsal surface by a strong carina.

   (Pronotum with a subvertical carina in front of prothoracic lobe; coarsely punctate species; abdominal hair bands consisting of a single row of plumose hairs on the extreme apical margins of tergites one to four or five, subapical hairs being involved only on the sides of the first tergite; male with but six exposed tergites; posterior coxae each with a longitudinal carina along inner ventral angle.) .....*Heriades*

... First abdominal tergite with anterior face sulcate or shallowly concave, not separated from dorsal surface by a carina.

   (Pronotum without a carina in front of posterior lobe; finely punctate forms; abdominal hair bands consisting, at least laterally, of more than a single row of hairs, some of which are subapical; posterior coxae with or without an inner ventral carina.) 3

3. First recurrent vein nearly interstitial with first transverse cubital (may be a short distance on either side of it); shortest distance between tegulae considerably greater than length of mesoscutum.

(Male with seven exposed tergites, sixth with a small tooth [sometimes inconspicuous] in posterior margin at each side, seventh quadrilobate; posterior coxae with only feeble suggestion of a carina on inner ventral angle.)....*Formicapis*

... First recurrent vein considerably distad to first transverse cubital; shortest distance between tegulae but little if any greater than length of mesoscutum.
(Male with six or seven exposed tergites; posterior coxal carina present or absent.) 4

4. Suture between mesothoracic and metathoracic pleurae practically straight in its long median section; clypeal truncation of female produced and overhanging base of labrum.

(Male with face below antennae covered with short, fine, appressed pubescence; abdomen of male with seven exposed tergites, sixth with a small tooth [sometimes hidden] in posterior margin at each side, seventh rounded at apex; posterior coxae without carinae on inner ventral angles.).....*Robertsonella*

... Suture between mesothoracic and metathoracic pleurae arcuate throughout; anterior margin of clypeus not much produced beyond base of labrum.
(Face of male with the usual, long pubescence; abdomen of male with six or seven exposed tergites, the sixth without lateral teeth; posterior coxae with or without inner ventral carinae.) 5

5. Male with but six exposed tergites and five exposed sternites, sixth tergite produced medially to an apical, rounded flange, and angulate laterally; clypeus of female produced to a slender, median, apical horn.
(Shortest distance between tegulae slightly greater than length of mesoscutum; posterior coxae with a longitudinal carina on inner ventral angle of each.).....
..... *Chelostomopsis*

... Male with seven exposed tergites and six exposed sternites; clypeus of female not greatly modified.
(Shortest distance between tegulae slightly less than length of scutum; posterior coxae carinate or not.) 6

6. Posterior coxae with a longitudinal carina on inner ventral angle of each; third segment of labial palpi flattened and connate with second, so that there is only one small, outstanding segment at end of each palpus. .....*Chelostoma*

... Posterior coxae without a longitudinal carina on inner ventral angle; third segment of labial palpi directed outward, so that there are two small, outstanding segments at the end of each palpus. .....*Prochelostoma*

7. Anterior face of mesepisternum large, shining and nearly impunctate, separated from lateral face by a weak prepectal carina; first abdominal tergite with anterior face consisting of a broad, shining concavity.

(Second abscissa of cubital vein usually twice as long as fourth; male with seventh abdominal tergite but little exposed, sixth quadridentate; posterior coxae with longitudinal carina on inner ventral angle.).....*Ashmeadiella*

... Anterior face of mesepisternum not separated from lateral face by a prepectal carina, sculpture of the two areas similar or intergrading on the rounded angle between them; first abdominal tergite with anterior face shallowly concave or provided with a longitudinal sulcus.

(Second abscissa of cubital vein normally less than twice as long as fourth; sixth abdominal tergite of male not quadridentate; posterior coxae with or without inner ventral carina.) 8

8. Notalices punctiform or short oval, at most three times as long as broad; sixth tergite of male without a tooth on posterior margin at each side; almost always metallic species. 9

... Notalices linear, much longer than broad; sixth tergite of male often with a tooth on each side of posterior margin; rarely metallic forms. 10

9. Posterior coxae with a longitudinal carina on inner ventral angle; notalices slightly elongated; carina separating propodeum laterally from lower portion of metapleura usually arched. ..... *Diceratosmia*

... Posterior coxae not carinate; notalices punctiform; carina separating propodeum laterally from lower portion of metapleura straight. ..... *Osmia*

10. First abdominal tergite with anterior face flat or slightly convex except for a longitudinal median sulcus, not separated from horizontal dorsal surface by a line or carina, except sometimes for a short distance across summit of sulcus.

(Posterior coxae with or without carina on inner ventral angle; sixth tergite of male with a tooth, sometimes very small or reduced to a mere angle, on margin at each side; body usually rather elongate.) 11

..... First abdominal tergite with anterior face broadly and usually shallowly concave, almost always separated from dorsal surface by a transverse, impressed line or feeble carina.

(Posterior coxae with a longitudinal carina or narrow impunctate line, rarely absent, along inner ventral angle; sixth tergite of male commonly not toothed at the sides; body short and robust, only rarely somewhat elongate.)..—*Anthocopa*

11. Posterior coxae with a longitudinal carina on inner ventral angle; trophi short, galeae and first two segments of labial palpi furnished with numerous strong hairs, the apices of which are hooked or bent and wavy. ..... *Proteriades*

..... Posterior coxae without an inner ventral carina, rarely with in impunctate line in its place (occasionally with a ventral carina whose distal end turns toward the outer rather than the inner side of the articulation of the trochanter); trophi long, without conspicuous hooked hairs. ..... *Hoplitis*

Genus HERIADES Spinola

Heriades Spinola, 1808, Ins. Ligur., **3**: 7, 198. Latreille, 1810, Consid. Génér. Ord. Nat. Anim., p. 439. Zetterstedt, 1840, Ins. Lapponica, p. 467. Lepeletier, 1841, Hist. Nat. Ins., Hymen., **2**: 404. Smith, 1846, Zoologist, **4**: 1447. Smith, 1854, Cat. Hymen. Brit. Mus., **2**: 221. Smith, 1855, Cat. Brit. Hymen. Ins., **1**: 191. Cresson, 1864, Proc. Ent. Soc. Philadelphia, p. 383. Shuckard, 1866, Brit. Bees, p. 288. C. G. Thomson, 1869, Opusc. Ent., **1**:21. C. G. Thomson, 1872, Skand. Hymen., **2**:262. Taschenberg, 1883, Berliner ent. Zeit., **27**: 62. Saunders, 1884, Trans. Ent. Soc. London, p. 214. Cresson, 1887, Trans. Am. Ent. Soc., Suppl., p. 132. Schletterer, 1889, Zool. Jahrb., Abt. f. Syst., Geog. u. Biol., **4**:650. Ashmead, 1899, Trans. Am. Ent. Soc., **26**: 73. Aurivillius, 1903, Ent. Tidsk., **24**: 171. Titus, 1904, Jour. N. Y. Ent. Soc., **12**: 23. Cockerell, 1906, Bull. Am. Mus. Nat. Hist., **22**: 445. Cockerell, 1910, Univ. Colo. Studies, **7**: 185. Sladen, 1916, Can. Ent., **48**:270. Viereck, 1916, Conn. Geol. Nat. Hist. Surv. Bull. **22**: 751. Benoist, 1928, Bull. Soc. ent. France, p. 122. Cockerell, 1931, Rev. Zool. Bot. Afr., **20**: 332. Michener, 1938, Ann. Ent. Soc. Am., **31**: 514. Sandhouse, 1939, Mem. Ent. Soc. Washington, **1**: 2.

Eriades Dalla Torre and Friese, 1895, Ent. Nachr., **21**: 69. Friese, 1898, Bienen Eur., 4: 9. Ducke, 1900, Ber. naturwiss. med. Ver. Innsbruck, **25**: 6. Friese, 1911, Das Tierreich, **28**: 8.

Type species: *Apis truncorum* Linnaeus, designated by Latreille, 1810.

Trypetes Schenck (nec Schönherr), 1859, Jahrb. d. Ver. f. Naturk. Nassau, **14**: 32, 39, 47, 89. Ashmead, 1899, Trans. Am. Ent. Soc., **26**: 73. Robertson, 1903, Trans. Am. Ent. Soc., **29**: 166. Friese, 1911, Das Tierreich, **28**: 8.
Type species: *Apis truncorum* Linnaeus (monobasic).

Subgeneric names:

1. *Neotrypetes* Robertson, 1918, Ent. News, **29**: 91. Cockerell, 1931, Rev. Zool. Bot. Afr., **20**: 332, 336. Michener, 1938, Ann. Ent. Soc. Am., **31**: 517.

Type species: *Trypetes productus* Robertson = *Megachile variolosa* Cresson, by original designation

2. *Physostetha* Michener, 1938, Ann. Ent. Soc. Am., **31**: 523.
Type species: *Heriades carinata* Cresson, by original designation.

The bees of the genus *Heriades* are small, rather slender, coarsely punctate, black forms, with the abdomen cylindrical, and curved downward at the tip in the males so that sometimes the apex of the last (sixth) exposed tergite touches the apex of the first sternite. The sternites of the male are mostly hidden, only the first two being largely exposed, one or two additional ones usually being slightly exposed. The coarse punctation and the strong carina surrounding the concavity of the base of the first tergite separate this genus easily from all other American Osmiinae. The mandibles are short, those of the female broad and tridentate, those of the male more slender and bidentate.

A number of facts suggest that this genus may be our most ancient representative of the Osmiinae. A number of species, referred to *Heriades*, have been described from the Oligocene shales of Florissant, Colorado. *Heriades* has the widest distribution of any genus of Osmiinae, occurring throughout the Holarctic and Ethiopian faunal region, extending well into the Oriental region and farther south in Central America than other Osmiinae. In the absence of relict forms, wide distribution is probably indicative of considerable age. Furthermore, *Heriades* and its closest relative (the African *Noteriades*) are very distinct from other Osmiinae in many respects. In spite of these facts, *Heriades* cannot be considered as a close approach to the primitive Osmiine type. The reduced number of exposed abdominal sclerites is only one of many indications of great specialization.

The American species of the genus have been recently reviewed (Michener, 1938).

Genus PROCHELOSTOMA Robertson

Prochelostoma Robertson, 1903, Trans. Am. Ent. Soc., **29**: 167, 171. Titus, 1904, Jour. N. Y. Ent. Soc., **12**: 24. Cockerell, 1906, Bull. Am. Mus. Nat. Hist., **22**: 445. Michener, 1938, Ent. News, **49**: 131. Sandhouse, 1939, Mem. Ent. Soc. Washington, **1**: 2.
Type species: *Heriades philadelphi* Robertson, by original designation.

This genus is closely related to *Chelostoma*, being distinguishable from it by the posterior coxal carina and the shape of the third segment of the labial palpi. The body form is the most elongate of any genus of Osmiinae, but is only slightly more slender than that of *Chelostoma*.

But one species, *P. philadelphi* (Robertson), found in the eastern United States, is placed in this genus.

Genus CHELOSTOMA Latreille

Chelostoma Latreille, 1809, Gen. Crust. Ins., **4**: 161. Curtis, 1837, Brit. Ent., **14**: 628. Lepeletier, 1841, Hist. Nat. Ins., Hymen., **2**:406. Smith, 1846, Zoologist, **4**:1445. Smith, 1854, Cat. Hymen. Ins. Brit. Mus., **2**:219. Smith, 1855, Cat. Brit. Hymen. Ins., **1**:187. Cresson, 1864, Proc. Ent. Soc. Philadelphia, p. 381. Shuckard, 1866, Brit. Bees, p. 283. C. G. Thomson, 1869, Opusc. Ent., **1**:21. C. G. Thomson, 1872, Skand. Hymen., **2**:257. Saunders, 1884, Trans. Ent. Soc. London, p. 213. Cresson, 1887, Trans. Am. Ent. Soc., Suppl., p. 132. Schletterer, 1889, Zool. Jahrb.,

abt. f. Syst., Geog., u. Biol., **4**:591. Ashmead, 1899, Trans. Am. Ent. Soc., **26**:73. Aurivillius, 1903, Ent. Tidsk., **24**:172. Cockerell, 1906, Bull. Am. Mus. Nat. Hist., **22**:445. Cockerell, 1910, Univ. Colo. Studies, **7**:185. Michener, 1938, Pan-Pac. Ent., **14**:36.

Type species: *Apis maxillosa* Linnaeus = *Apis florisomnis* Linnaeus (monobasic).

Gyrodroma C. G. Thomson (nec Klug) 1869, Opusc. Ent., **1**:22. C. G. Thomson, 1872, Skand. Hymen., **2**:259. Aurivillius, 1903, Ent. Tidsk., **24**:172. Cockerell, 1925, Proc. Calif. Acad. Sci., (4) **14**:205.

Type species: *Heriades nigricornis* Nylander, designated by Cockerell, 1925.

Chelostoma may be distinguished from all other bees known to me by the form of the third segment of the labial palpi, which is flattened and broadly attached to the preceding segment, so that there is but one small, freely movable segment apically. The species of this genus are moderate sized to small, slender, black forms. The seventh abdominal segment of the male is, in American forms, furnished with three or four large teeth.

The species of this genus are rather widely distributed in Eurasia, but in the New World they are known only from the Pacific Coast states, from which region four species have been described. These American species and their forms have been recently revised (Michener, 1938).

Genus Chelostomopsis Cockerell

Chelostomopsis Cockerell, 1925, Proc. Calif. Acad. Sci., (4) **14**:205. Michener, 1938, Ent. News, **49**:127.

Type species: *Chelynia rubifloris* Cockerell, by original designation.

Raphidostoma Cockerell, 1936, Pan-Pac. Ent., **12**: 133.

Type species: *Raphidostoma ceanothi* Cockerell = *Chelynia rubifloris* Cockerell, by original designation.

This genus is probably more closely related to *Chelostoma* than to any other group. It contains small black bees, more robust, both in thorax and abdomen, than *Chelostoma*. The abdomen of the male has only six exposed tergites, and the female may be easily distinguished from our other species by the long, apical process on the short, broad clypeus, and by the long, slender, straight, bidentate mandibles.

Only one species, *Chelostomopsis rubifloris* (Cockerell), is placed in this genus. It occurs in the Pacific Coast states.

Genus Formicapis Sladen

Formicapis Sladen, 1916, Can. Ent., **48**: 271. Cockerell, 1922, Can. Ent., **54**: 144. Michener, 1938, Ent. News, **49**: 129.

Type species: *Formicapis clypeata* Sladen (monobasic).

The genus *Formicapis* includes a small, black species, having much the same body form as *Chelostomopsis*, although the thorax is more robust than in that genus. Indeed the shape of the mesoscutum, which is distinctly shorter than the shortest distance between tegulae, is indicative of a relationship with the Osmiini which is further indicated by the somewhat reduced size of the pterostigma, and the presence of a minute tooth on each side of the sixth tergite in the male, as in *Hoplitis*. However, the relatively horizontal metanotum and the moderate sized stigma indicate its affinities with the Heriadini.

The female is easily recognized by the short, broad clypeus, the apical margin of which is furnished with a short, broad, snout-like, projecting process. The mandibles of the female are long and broad, quadridentate; the two inner teeth, however, are mere, feeble convexities in the long, apical margin of the mandibles.

The only known species is found in the Rocky Mountain region from Alaska to Colorado.

Genus ROBERTSONELLA Titus

Robertsonella Titus, 1904, Jour. N. Y. Ent. Soc., **12**: 22. Cockerell, 1906, Bull. Am. Mus. Nat. Hist., **22**:445. Cockerell, 1910, Univ. Colo. Studies, **7**: 185, 191. Michener, 1938, Ent. News, **49**: 130.

Type species: *Robertsonella gleasoni* Titus = *Heriades simplex* Cresson, by original designation.

The representatives of this genus are small, black bees, having the general appearance of *Chelostomopsis* or of *Hoplitis producta* (Cresson). Like *Formicapis*, this genus occupies a position intermediate between the Heriadini and the Osmiini. Although the mesoscutum is more slender than in *Formicapis*, *Robertsonella* is, I believe, even more closely related to *Hoplitis* than is *Formicapis*. In spite of this, the position of the metanotum on the dorsal surface of the thorax and the rather large pterostigma have led me to place *Robertsonella* in the *Heriadini*. The mandibles of the female are short, broad, tridentate, and the apical margin of the clypeus is broadly truncate, the truncated margin being at least twice as long as the distance between the antennal scrobes.

Two species of *Robertsonella* are known, one from the eastern states with a subspecies in Texas, the other from California.

When reviewing the forms of this genus in 1938, I failed to realize that *Osmia gracilis* Michener (1935, Pan-Pac. Ent., 11:183) was a *Robertsonella*, closely related to the eastern *R. simplex* (Cresson). In *Robertsonella gracilis* (Michener) (new combination) the abdomen is rather coarsely punctate as in the typical eastern form of *simplex*, from which it differs in the female (male unknown) by being slightly smaller and more slender, and in having the distance between the posterior ocelli conspicuously less than the distance from one of them to the nearest eye margin, instead of about equal to the latter distance as in *simplex*.

Genus ASHMEADIELLA Cockerell

Ashmeadiella Cockerell, 1897, Ent. News, **8**: 197. Cockerell, 1898, Bull. Denison Univ., **11**: 41. Cockerell, 1898, Bull. Univ. New Mex., **1**: 41. Ashmead, 1899, Trans. Am. Ent. Soc., **26**: 73. Cockerell and Porter, 1899, Ann. Mag. Nat. Hist., (7)**4**: 404. Cockerell and Atkins, 1902, Ann. Mag. Nat. Hist., (7)**9**: 233. Robertson, 1903, Trans. Am. Ent. Soc., **29**: 167. Cockerell, 1906, Bull. Am. Mus. Nat. Hist., **22**: 445. Cockerell, 1910, Univ. Colo. Studies, **7**: 185. Sladen, 1916, Can. Ent., **48**: 270. Michener, 1936, Am. Mus. Novit., **875**: 1. Michener, 1939, Am. Midland Nat., **22**: 1. Sandhouse, 1939, Mem. Ent. Soc. Washington, **1**: 2.
Type species: *Heriades opuntiae* Cockerell, by original designation.

Subgeneric names:

1. *Arogochila* Michener, 1939, Am. Midland Nat., **22**: 58.
Type species: *Ashmeadiella timberlakei* Michener, by original designation.

2. *Chilosima* Michener, 1939, Am. Midland Nat., **22**: 78.
Type species: *Ashmeadiella rhodognatha* Cockerell, by original designation.

3. *Corythochila* Michener, 1939, Am. Midland Nat., **22**: 74.
Type species: *Ashmeadiella inyoensis* Michener, by original designation.

4. *Cubitognatha* Michener, 1939, Am. Midland Nat., **22**: 81.
Type species: *Ashmeadiella xenomastax* Michener, by original designation.

5. *Titusella* Cockerell, 1906, Bull. Am. Mus. Nat. Hist., **22**: 445. Cockerell, 1910, Univ. Colo. Studies, **7**: 185. Michener, 1936, Am. Mus. Novit., 875: 1. Michener, 1939, Am. Midland Nat., **22**: 53.

Type species: *Titusella pronitens* Cockerell, by original designation.

The genus *Ashmeadiella* consists of rather small, robust, black bees, often with the basal part of the abdomen red. It may be distinguished from other American Osmiinae by the presence of weak carinae separating the anterior from the lateral faces of the mesepisterna. Males may be more conveniently recognized by the four large teeth on the posterior margin of the sixth tergite. The mandibles are highly variable, two or three toothed in the males, two to five toothed in the females.

This genus is confined to North America, and is most abundant in the arid western states. The species of the genus have been recently revised (Michener, 1939).

Genus Hoplitis Klug

Hoplitis Klug, 1807, Mag. f. Insektenk., **6**: 225. Ashmead, 1899, Trans. Am. Ent. Soc., **26**: 76. Titus, 1904, Proc. Ent. Soc. Washington, **6**: 101. Cockerell, 1906, Bull. Am. Mus. Nat. Hist., **22**: 445. Sandhouse, 1939, Mem. Ent. Soc. Washington, **1**: 3.

Type species: *Apis adunca* Panzer (monobasic).

Ctenosmia C. G. Thomson, 1872, Skand. Hymen., **2**: 233. Schmiedeknecht, 1886, Apid. Europ., **2**: 887.
Type species: *Apis adunca* Panzer, by present designation.

Subgeneric names:

1. *Alcidamea* Cresson, 1864, Proc. Ent. Soc. Philadelphia, **2**: 385. Cresson, 1887, Trans. Am. Ent. Soc., Suppl., p. 133. Ashmead, 1899, Trans. Am. Ent. Soc., **26**: 74. Cockerell and Porter, 1899, Ann. Mag. Nat. Hist., (7)**4**: 404. Friese, 1902, Zeitschr. Hymen. Dipt., **2**: 188. Cockerell, 1906, Bull. Am. Mus. Nat. Hist., **22**: 445. Cockerell, 1910, Univ. Colo. Studies, **7**: 185. Sladen, 1916, Can. Ent., **48**: 272.

Type species: *Alcidamea producta* Cresson, by present designation.

Autochelostoma Sladen, 1916, Can. Ent., **48**: 270. Cockerell, 1922, Can. Ent. **54**: 143. (new synonym).

Type species: *Autochelostoma canadensis* Sladen = a gynandromorph of *Alcidamea producta* Cresson (monobasic).

2. *Andronicus* Cresson, 1864, Proc. Ent. Soc. Philadelphia, **2**: 384. Cresson, 1887, Trans. Am. Ent. Soc., Suppl., p. 133. Ashmead, 1899, Trans. Am. Ent. Soc., **26**: 74. Friese, 1902, Zeitschr. Hymen. Dipt., **2**: 188. Cockerell, 1906, Bull. Am. Mus. Nat. Hist., **22**: 445. Sladen, 1916, Can. Ent., **48**: 271. Viereck, 1916, Conn. Geol. Nat. Hist. Surv. Bull. **22**: 750.

Type species: *Andronicus cylindricus* Cresson (monobasic).

3. *Hoplitina* Cockerell, 1913, Can. Ent., **45**: 34. Cockerell, 1922, Am. Mus. Novit., **40**: 5.

Type species: *Hoplitella pentamera* Cockerell, by original designation.
Hoplitella Cockerell (nec Levinsen), 1910. Can. Ent., **42**: 169.

Type species: *Hoplitella pentamera* Cockerell (monobasic).

4. *Liosmia* C. G. Thomson, 1872, Skand. Hymen., **2**:233. Friese, 1911, Das Tierreich, **28**:438.

Type species: *Osmia claviventris* Thomson, by present designation.

5. *Monumetha* Cresson, 1864, Proc. Ent. Soc. Philadelphia, **2**:387. Cresson, 1887, Trans. Am. Ent. Soc., Suppl., p. 133. Ashmead, 1899, Trans. Am. Ent. Soc., **26**:74. Titus, 1904, Jour. N. Y. Ent. Soc., **12**:26. Cockerell, 1910, Univ. Colo. Studies, **7**:185. Sladen, 1916, Can. Ent. **48**:271.

Type species: *Monumetha argentifrons* Cresson = *Chelostoma albifrons* Kirby, by designation of Titus, 1904.

Chlorosmia Sladen, 1916, Can. Ent., **48**: 270, 271. Michener, 1936, Am. Mus. Novit., **875**:28.

Type species: *Osmia fulgida* Cresson (monobasic).

6. *Tridentosmia* Schmiedeknecht, 1886, Apid. Europ., **2**: 887. Ashmead, 1899, Trans. Am. Ent. Soc., **26**: 75.

Type species: *Osmia tridentata* Dufour and Perris, by present designation.

In their treatment of the genera related to *Osmia,* European and American students have followed widely different paths. The European workers have placed the entire group in a single genus, *Osmia,* divided into a number of subgenera, some of which were unnatural, and to some of which untenable names were applied, as indicated in the synonymies of this and other genera. American authors, on the other hand, following the example of Cresson, have usually recognized a considerable number of genera, especially among the forms related to *Hoplitis.* In the present paper, I have followed an intermediate course by recognizing three great genera, *Osmia, Anthocopa* and *Hoplitis,* each with a number of subgenera. This procedure indicates much more accurately than any of the others what I believe to be the phylogenetic relationships of the forms concerned.

Of these three genera, *Osmia* is the most distinct because of its punctiform notalices. The other two genera, *Hoplitis* and *Anthocopa,* and in addition *Proteriades,* are closely related, and the last two both intergrade rather completely with certain sections of *Hoplitis,* so that the lines chosen to separate the genera are of necessity somewhat arbitrary. Nevertheless, these genera are distinctive types, each having a habitus of its own. Their recognition as genera makes possible a grouping of allied forms to indicate the relationships of the subgenera and species. If *Anthocopa* were to be regarded as a subgenus of *Hoplitis, Proteriades* would have to be similarly treated.

Hoplitis consists of small to rather large, slender bees, usually with the abdomen elongate and parallel sided. They are mostly black, but a few are brilliantly metallic *(Chorosmia)* and a few have the abdomen largely red *(Hoplitina).* From *Anthocopa* and *Proteriades, Hoplitis* may be distinguished by the more slender form. The posterior coxae lack carinae on their inner ventral angles, or rarely such carinae are indicated by inconspicuous, impunctate lines. The anterior face of the first abdominal tergite is usually but little longer than the dorsal face, and is furnished with a longitudinal sulcus; the two faces of the tergite are not separated by a transverse line or carina, but, with a few exceptions, there is a region of transition between the sculpture of the two faces. The sixth tergite of the male bears a tooth at each side, some-

times very small, and rarely reduced to a mere angle (absent in *H. rufohirta* (Latreille). The seventh sternite, in the male, is somewhat elongate· the emargination in its basal margin being usually broadly V-shaped, only rarely U-shaped or evenly curved. The parameres of the male genitalia are not united basally by a sclerotic area having a distal, acute point. The antennae of the males are commonly more or less thickened and modified. Certain further notes on the distinctions between *Hoplitis* and *Anthocopa* will be found in the discussion of the latter genus.

It will be clear from the preceding synonymy which American groups are to be included in *Hoplitis*. The European species which I have seen are *Hoplitis adunca* (Panzer), *manicata* (Morice), *claviventris* (Thomson), *tuberculata* (Nylander), *parvula* (Dufour and Perris), *leucomelaena* (Kirby), *rufohirta* (Latreille) and *tridentata* (Dufour and Perris), (new combinations, except for the first).

The genus *Hoplitis* is Holarctic in distribution.

Genus Proteriades Titus

Proteriades Titus, 1904, Jour. N. Y. Ent. Soc., **12**: 25. Cockerell, 1906, Bull. Am. Mus. Nat. Hist., **22**: 445. Sandhouse, 1939, Mem. Ent. Soc. Washington, **1**: 2.
Type species: *Heriades semirubra* Cockerell, by original designation.

Cephalapis Cockerell, 1910, Ann. Mag. Nat. Hist., (8)**5**: 23. (New synonym).
Type species: *Chelostoma jacintanum* Cockerell (monobasic).

These are small bees having much the aspect of *Ashmeadiella* except that the abdomen of the male is usually more slender apically; the sixth tergite of the male is not quadridentate, but has a small tooth or angle at each side, and the seventh is bidentate or more or less bilobed. The abdomen is almost always red basally. As in *Hoplitis*, the first abdominal tergite lacks a line separating the anterior from the dorsal face, and has a sulcus on the anterior face. *Proteriades* differs from *Hoplitis* in the short mouthparts, the galeae and long segments of the labial palpi of which are furnished with long, hooked or wavy bristles, and in the carinate inner ventral angles of the posterior coxae.

Bees of the genus *Proteriades* are known from California, and undoubtedly occur in certain neighboring states. *Cephalapis* is a divergent type of *Proteriades*, and when the species of the genus have been properly studied, it may be given subgeneric standing.

Genus Anthocopa Lepeletier

Anthocopa Lepeletier, 1825, Ency. méth. (Ins.) **10**:314. Lepeletier, 1841, Hist. Nat. Ins., Hymen., **2**:348. Blanchard, 1845, Hist. des Ins., p. 12. Shuckard, 1866, Brit. Bees, p. 290. C. G. Thomson, 1872, Skand. Hymen., **2**:233. Ashmead, 1899, Trans. Am. Ent. Soc., **26**: 76.

Type species: *Apis papaveris* Latreille (monobasic).

Phyllotoma Duméril, 1860, Mém. Acad. Sci. Paris, **31**: 843.

Type species: *Apis papaveris* Latreille, by present designation.

Furcosmia Schmiedeknecht, 1886, Apid. Europ., **2**: 888. Cockerell, 1922, Am. Mus. Novit., **40**:6.

Type species: *Apis papaveris* Latreille, by designation of Cockerell, 1922.

Pseudosmia Radoszkowski, 1872, Horae Soc. Ent. Ross., **8**: 18. Cockerell, 1905. Trans. Am. Ent. Soc., **31**: 332. Cockerell, 1922, Am. Mus. Novit., **40**: 6.

Pseudoosmia Radoszkowski, 1872, Bull. Soc. Moscou, **48**: 152.

Pseudocosmia Radoszkowski, 1886, Horae Soc. Ent. Ross., **20**: 14.

Type species: *Megachile cristata* Fonscolombe, by designation of Cockerell, 1922.

Subgeneric names:

1. *Atoposmia* Cockerell, 1935, Pan-Pac. Ent., **11**:50. Michener, 1936, Can. Ent., **68**: 41.

   Type species: *Osmia triodonta* Cockerell, by original designation.

2. *Erythrosmia* Schmiedeknecht, 1886, Apid. Europ., **2**: 886. Cockerell, 1922, Am. Mus. Novit., 40: 6.

   Type species: *Osmia andrenoides* Spinola, by designation of Cockerell, 1922.

3. *Hoplosmia* C. G. Thomson, 1872, Skand. Hymen., **2**: 233. Schmiedeknecht, 1886, Apid. Europ., **2**: 889. Ashmead, 1899, Trans. Am. Ent. Soc., **26**: 75.

   Type species: *Apis spinulosa* Kirby, by present designation.

The name *Anthocopa* has previously been used, when it has appeared at all, only for the type species, *papaveris*, and its immediate relatives. In the present classification, however, (see discussion under *Hoplitis*) it is the oldest name for a large group of species of diverse aspects. They are black, sometimes with the base of the abdomen red *(Erythrosmia)*. Most groups are robust, shaped as in *Osmia*. The inner ventral margin of each posterior coxa is marked by a longitudinal carina, sometimes weak, or at least by a feeble, shining line. In certain forms from both the Nearctic and Palearctic regions, the carina is reduced and inconspicuous or even absent. The first abdominal tergite has the anterior face broadly concave and separated from the dorsal surface by an impressed line or feeble carina, or at least by a line formed by the more or less abrupt termination of the shining surface of the concavity. (A line of the latter type is sometimes found also in *Hoplitis*.) As in *Osmia*, and in contrast to *Hoplitis*, the dorsal surface of the first tergite is shorter than the anterior face. The posterior lobe of the pronotum is generally separated by a vertical ridge, absent in *Hoplitis*, from the remainder of the pronotum. The antennae of the males are not deformed among species thus far observed by me, and the sixth abdominal tergite of the males bears lateral teeth only in a few groups. The seventh abdominal sternite of the male, in most *Anthocopa*, is very short and broad, the basal margin broadly concave, not V-shaped as is usually the case in *Hoplitis*. The male genitalia in most *Anthocopa*, although not in the type species or in certain others, have a small sclerotized area between the bases of the parameres, the apical margin of which is produced caudad as a small point between the parameres. Such a point is absent in other genera.

Although most of the species of *Anthocopa* possess all of the distinctive generic characteristics, an occasional species lacks one or more of them. Thus *A. xerophila* (Cockerell) lacks a distinct line between the faces of the first tergite; yet it is placed in *Anthocopa* rather than *Hoplitis* because of the strong carina on each hind coxa, the absence of a tooth on each side of the sixth tergite of the male, and the rather broadly concave anterior face of the first tergite. *Tridentosmia* and *Acanthosmia*, here regarded as subgenera of *Hoplitis*,

are closely related to *Anthocopa*, and it seems probable that it was from such groups that *Anthocopa* arose.

In addition to the American species already placed in *Atoposmia*, the following are included in *Anthocopa*, mostly in subgenera yet to be named: *Osmia albomarginata, arefacta, copelandica, enceliae, hemizoniae, palmarum, phaceliarum, robustula, rupestris, shastensis, timberlakei, viguierae*, and *xerophila*, all described by Cockerell. The Old Word species at hand are *Anthocopa papaveris* (Latreille), *singularis* (Morawitz), *longispina* (Pérez), *cristata* (Fonscolombe), *cyprica* (Mavromoustakis), *transcaspica* (Morawitz), *crenulata* (Morawitz), *andrenoides* (Spinola), *paradoxa* (Friese), *spinulosa* (Kirby), *bidentata* (Morawitz), *ligurica* (Morawitz), *anceyi* (Pérez), *calviniae* (Cockerell) (Africa), and *monilifera* (Cockerell) (*Thaumatosoma*[1] *moniliferum* Cockerell, Africa) (all new combinations except *papaveris*).

Anthocopa occurs in Eurasia, Africa, and in North America east to the Rocky Mountains.

Genus Diceratosmia Robertson

Diceratosmia Robertson, 1903, Trans. Am. Ent. Soc., **29**: 166, 171. Cockerell, 1912, Proc. U. S. Nat. Mus., **42**: 216. Sandhouse, 1939, Mem. Ent. Soc. Washington, **1**: 2.

Type species: *Osmia quadridentata* Cresson = *Osmia conjuncta* Cresson, by original designation.

This genus consists of robust species, closely related to *Osmia*, from which they differ primarily in the presence of a carina along the inner ventral angle of each posterior coxa. The notalices, while much reduced, are slightly longer than in *Osmia*. In New World species other than the Mexican and Central American *D. azteca* (Cresson), the carina marking the dorsal border of the lower section of the metapleura is arched. Again with the exception of *azteca*, our species of *Diceratosmia* are metallic blue.

This is a Holarctic group which extends southward to Costa Rica in this hemisphere. Old World species before me which apparently belong to this genus are *D. submicans* (Morawitz) and *D. rufigastra* (Lepeletier).

Genus Osmia Panzer

Osmia Panzer, 1806, Krit. Revis. Insekt. Deutsch., **2**: 230. Spinola, 1806, Ins. Ligur., **3**: 200. Latreille, 1810, Cons. Génér. Ord. Nat. Anim., p. 439. Lepeletier, 1841, Hist. Nat. Ins., Hymen., **2**: 312. Smith, 1853, Cat. Hymen. Brit. Mus., **1**: 137. Shuckard, 1866, Brit. Bees, p. 294. C. G. Thomson, 1869, Opusc. Ent., **1**: 20. C. G. Thomson, 1872, Skand. Hymen., **2**: 231. Radoszkowski, 1872, Horae Soc. Ent. Ross., **8**: bull. p. xviii. Provancher, 1883, Petite Faun. Ent. Canad. Hymen., p. 706. Taschenberg, 1883, Berliner ent. Zeit., **27**: 59. Saunders, 1884, Trans. Ent. Soc. London, p. 204. Schmiedeknecht, 1886, Apid. Europ., **2**: 869. Cresson, 1887, Trans. Am. Ent. Soc., Suppl., p. 133. Ashmead, 1899, Trans. Am. Ent. Soc., **26**:75. Ducke, 1900, Ber. naturwiss.-med. Ver. Innsbruck, **25**: 6. Titus, 1901, Can. Ent., **33**: 257. Robertson, 1903, Trans. Am. Ent. Soc., **29**: 166. Aurivillius, 1903, Ent. Tidsk., **24**: 165. Titus, 1904, Jour. N. Y. Ent. Soc., **12**: 26. Cockerell, 1910, Univ. Colo. Studies, **7**: 185, 190. Friese, 1911, Das Tierreich, **28**: 7, 32. Cockerell, 1912, Proc. U. S. Nat. Mus., **42**: 215. Sladen, 1916, Can. Ent., **48**: 270.

1 The true *Thaumatosoma* is an Australian bee, probably in the Megachilinae.

Viereck, 1916, Conn. Geol. Nat. Hist. Surv. Bull. **22**: 748. Benoist, 1928, Bull. Soc. ent. France, p. 122. Michener, 1936, Am. Mus. Novit., **875**: 28. Sandhouse, 1939, Mem. Ent. Soc. Washington, **1**: 3.

Type species: *Apis bicornis* Linnaeus = *Apis rufa* Linnaeus, designated by Latreille, 1810.

Amblys Klug, 1807, Mag. f. Insektenk., **6**: 198, 226. Latreille, 1811, Encycl. Méth. Hist. Nat. Ins., **8**: 577. Ashmead, 1899, Trans. Am. Ent. Soc., **26**: 75.

Type species: *Apis bicornis* Linnaeus = *Apis rufa* Linnaeus, designated as *rufa* by Latreille, 1811.

Ceratosmia C. G. Thomson, 1872, Skand. Hymen., **2**:232, 235. Schmiedeknecht, 1886, Apid. Europ., **2**: 885. Ashmead, 1899, Trans. Am. Ent. Soc., **26**: 74. Robertson, 1903, Trans. Am. Ent. Soc., **29**: 165, 166, 170. Cockerell, 1912, Proc. U. S. Nat. Mus., **42**: 216; Sandhouse, 1939, Mem. Ent. Soc. Washington, **1**: 9.

Type species: *Apis bicornis* Linnaeus = *Apis rufa* Linnaeus, designated by Sandhouse, 1939.

Aceratosmia Schmiedeknecht, 1886, Apid. Europ., **2**: 885. Ashmead, 1899, Trans. Am. Ent. Soc., **26**: 75. Sandhouse, 1939, Mem. Ent. Soc. Washington, **1**: 9.

Type species: *Osmia emarginata* Lepeletier, designated by Sandhouse, 1939.

Pachyosmia Ducke, 1900, Ber. naturwiss.-med. Ver. Innsbruck, **25**: 6. Sandhouse, 1939, Mem. Ent. Soc. Washington, **1**: 9.

Type species: *Apis rufa* Linnaeus, designated by Sandhouse, 1939.

Subgeneric names:

1. *Acanthosmioides* Ashmead, 1899, Trans. Am. Ent. Soc., **26**: 76. Cockerell, 1912, Proc. U. S. Nat. Mus., **42**: 216. Sandhouse, 1939, Mem. Ent. Soc. Washington, **1**: 39.

   Type species: *Osmia odontogaster* Cockerell, by original designation.

2. *Cephalosmia* Sladen, 1916, Can. Ent., **48**: 270. Sandhouse, Mem. Ent. Soc. Washington, **1**: 21.

   Type species: *Osmia armaticeps* Cresson = *Osmia montana* Cresson (monobasic).

3. *Chalcosmia* Schmiedeknecht, 1886, Apid. Europ., **2**: 886. Ducke, 1900, Ber. naturwiss.-med. Ver. Innsbruck, **25**: 6. Friese, 1911, Das Tierreich, **28**: 108. Sandhouse, 1939, Mem. Ent. Soc. Washington, **1**: 13.

   Type species: *Apis fulviventris* Panzer = *Apis ventralis* Panzer, designated by Sandhouse, 1939.

   Gnathosmia Robertson, 1903, Trans. Am. Ent. Soc. **29**: 165, 171. Cockerell, 1912, Proc. U. S. Nat. Mus., **42**: 216.

   Type species: *Osmia georgica* Cresson, by original designation.

4. *Helicosmia* C. G. Thomson, 1872, Skand. Hymen., **2**: 233. Schmiedeknecht, 1886, Apid. Europ., **2**: 888.

   Type species: *Apis aurulenta* Panzer, by present designation.

5. *Melanosmia* Schmiedeknecht, 1886, Apid. Europ., **2**: 885. Ashmead, 1899, Trans. Am. Ent. Soc. **26**: 75. Cockerell, 1912, Proc. U. S. Nat. Mus., **42**: 216. Sandhouse, 1939, Mem. Ent. Soc. Washington, **1**: 33.

   Type species: *Osmia fuciformis* Latreille, designated by Sandsouse, 1939.

   Centrosmia Robertson, 1903, Trans. Am. Ent. Soc., **29**: 165, 166, 170. Cockerell, 1912, Proc. U. S. Nat. Mus., **42**: 216.

   Type species: *Osmia bucephala* Cresson, by original designation.

6. *Nothosmia* Ashmead, 1899, Trans. Am. Ent. Soc., **26**: 75. Cockerell, 1912, Proc. U. S. Nat. Mus., **42**: 216. Sandhouse, 1939, Mem. Ent. Soc. Washington, **1**: 63. Type species: *Osmia distincta* Cresson, by original designation.

   Leucosmia Robertson, 1903, Trans. Am. Ent. Soc., **29**: 166, 171. Cockerell, 1912, Proc. U. S. Nat. Mus., **42**: 216.

Type species: *Osmia albiventris* Cresson, by original designation.

Monilosmia Robertson, 1903, Trans. Am. Ent. Soc., **29**: 166, 171. Cockerell, 1912, Proc. U. S. Nat. Mus., **42**: 216.

Type species: *Osmia canadensis* Cresson = *Osmia simillima* Smith, by original designation.

Xanthosmia Robertson, 1903, Trans. Am. Ent. Soc., **29**: 166, 171. Cockerell, 1912, Proc. U. S. Nat. Mus., **42**: 216.

Type species: *Osmia cordata* Robertson, by original designation.

The genus *Osmia* consists of robust bees, nearly all of the North American species of which are more or less metallic. *Osmia* is distinguishable from all other genera by its reduced, punctiform notalices, although its nearest relative, *Diceratosmia*, has very short notalices, but is easily distinguished by the posterior coxal carinae.

The groups of *Osmia* (sense of European authors) which fall into *Osmia* as here restricted have been relatively well understood, so that the preceding synonymy indicates which forms are here included in the genus.

Species of *Osmia* are found throughout the Holarctic region. The American forms have been recently revised (Sandhouse, 1939).

Genera not Found in America

Genus NOTERIADES Cockerell

Noteriades Cockerell, 1931, Rev. Zool. Bot. Afr., **20**: 332. Michener, 1938, Ann. Ent. Soc. Am., **31**: 514.

Type species: *Megachile tricarinatus* Bingham, by original designation.

This is a genus of coarsely punctured bees, related to *Heriades* as shown by the marked similarities in the form of the hidden sternites and the retracted sixth tergite of the male, and by the large stigma. Yet the thorax is short and robust as in the Osmiini. No doubt this condition has arisen independently in the two tribes.

Clypeus and supraclypeal area with a longitudinal median carina; clypeus but little produced over base of labrum; mandibles short and broad, tridentate in the female, bidentate in the male; posterior concavity of head surrounded by a strong occipital carina (observed in no other Osmiinae); antennae of male reaching posterior end of thorax. Thorax short and robust; posterior lobe of pronotum separated from rest of pronotum by a vertical carina; mesepisternum with a prepectal carina separating the anterior from the lateral faces except above; shortest distance between tegulae much greater than length of mesoscutum; notalices linear; distance between inner angles of the edentate axillae much greater than length of short, broad mesoscutellum, which is broadly truncated posteriorly and a subapical fold is produced farther posteriorly than the true apical margin; metanotum and posterior face of propodeum nearly vertical, only weakly punctured; posterior coxae with a carina on ventral, inner angle of each; pterostigma approximately as in *Heriades;* apex of marginal cell bent away from costal margin of wing. Abdomen of male with but six exposed tergites and two exposed sternites. Certain other features are

recorded in the discussion of generic characters near the beginning of this paper. This is an African genus, of which I have seen only the type species.

Genus **Stenosmia** n. g.

Type species: *Osmia flavicornis* Morawitz.

This is a genus of small slender bees, apparently best placed in the Heriadini because of the large stigma, although the thorax is similar to that of some Osmiini.

Clypeus with apical margin somewhat irregularly rounded and produced slightly over base of labrum; mandibles of male short, bidentate, of female rather slender, tridentate, the apical tooth long; maxillary palpi short, apparently with four free segments, the first of which is much reduced, the second longest, as long as third and fourth together; first segment of labial palpi slightly shorter than second; antennae of male simple but rather long, reaching middle of scutellum. Thorax rather robust; posterior lobe of pronotum separated from rest of pronotum by a weak, subvertical carina; mesepisternum with a prepectal carina separating, except above, the shining anterior face from the dull lateral face; shortest distance between tegulae slightly greater than length of mesoscutum; line between anterior ends of tegulae crosses scutum anterior to its middle; notalices linear; distance between inner angles of the edentate axillae somewhat greater than length of mesoscutellum; scutellum strongly convex; metanotum on dorsal surface of thorax but considerably below a line tangent to convexities of scutum and scutellum, highest near anterior end; propodeum with a subhorizontal basal zone; declivity of propodeum slanting considerably; carinae separating propodeum from lower portions of metapleurae weak and straight; posterior coxae with a weak, longitudinal carina on inner ventral angle; pterostigma large (see figure), apex of marginal sell somewhat bent away from costal margin of wing. Abdomen rather elongate, parallel sided, first tergite with broad concavity in anterior face, but no line or carina separating it from dorsal face; abdomen of male with seven exposed tergites, the sixth and seventh simple, not toothed; sternites one to five of male exposed and unmodified; coxopodites of male genitalia broad, broadest apically where they converge slightly.

This genus differs from *Chelostoma* by the less elongate notalices, from *Heriades* by the fine punctation, from both of these as well as from the various small American Heriadini by the unusually large stigma and the presence of a prepectal carina, from *Hoplitis* by the last two characters mentioned, as well as by the carinate posterior coxae and the untoothed lateral margins of the sixth tergite in the male, from *Anthocopa* by the slender form, absence of a transverse line separating the faces of the first abdominal tergite, large stigma, etc *Stenosmia* may be separated from *Protosmia* by the tridentate mandibles of the female and the exposed seventh tergite of the male.

Stenosmia flavicornis (Morawitz) is the only species known to belong to this genus. I have specimens of it, sent by Mr. V. B. Popov, from Satchow,

Gobi, Central Asia, August 7, 1895 (P. Kozlov), determined by Friese in 1910, and agreeing rather well with descriptions of *flavicornis*.

The groups listed below were described, with the exception of the last, as subgenera of *Osmia*. I have not seen specimens of them, but suspect that most will be placed as subgenera of *Osmia*, *Anthocopa*, or *Hoplitis*. None of these forms is recorded from the New World.

Acanthosmia C. G. Thomason, 1872, Skand. Hymen., **2**: 233. Schmiedeknecht, 1886, Europe., **2**: 886. Ashmead, 1899, Trans. Am. Ent. Soc., **26**: 75.

Arctosmia Schmiedeknecht, 1886, Apid. Europ., **2**: 887. Ashmead, 1899, Trans. Am. Ent. Soc., **26**: 75.

Aspidosmia Brauns, 1926, Zool. Jahrb., Abt. I. Syst., Ökol. u. Geog., **52**: 208.

Lithosmia Alfken, 1935, Veröff. deutsch. Kol. Mus. Bremen, **2**: 189.

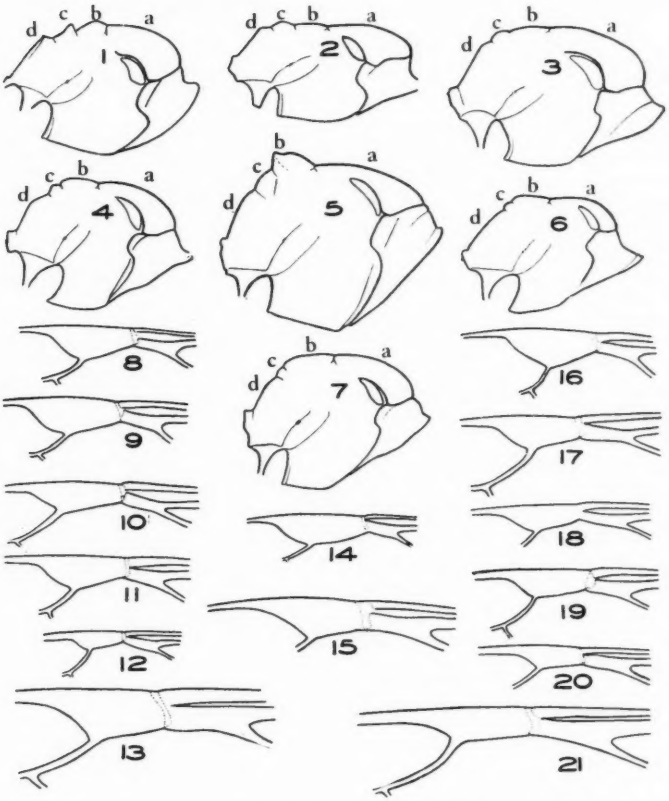
Megalosmia Schmiedeknecht, 1886, Apid. Europ., **2**: 889. Ashmead, 1899, Trans. Am. Ent. Soc., **26**: 75.

Protosmia Ducke, 1900, Ber. naturwiss.-med. Ver. Innsbruck, **25**: 12.

Heriadopsis Cockerell, 1931, Rev. Zool. Bot. Afr., **20**: 338.

The genus *Fertonella* Cockerell (1920, Ann. Durban Mus., 2:257, new name for *Perezia* Ferton, Ann. Soc. ent. France, 83:233), described as an Osmiine bee by Ferton, is a parasitic form without pulvillae, presumably not to be included in the Osmiinae.

University of California,
Berkeley, California.



Figs. 1 to 7. Semidiagramatic lateral views of thoraces, all drawn to the same scale. (a, mesoscutum; b, mesoscutellum; c, metanotum; d, propodeum.) 1, *Heriades carinata* Cresson. 2, *Prochelostoma philadelphi* (Robertson). 3, *Robertsonella simplex* (Cresson). 4, *Stenosmia flavicornis* (Morawitz). 5, *Noteriades tricarinatus* (Bingham). 6, *Hoplitis producta* (Cresson). 7, *Anthocopa albomarginata* (Cockerell). Figs. 8 to 21. Pterostigmata and adjacent parts of wings, all drawn to same scale. 8, *Heriades carinata* Cresson. 9, *Noteriades tricarinatus* (Bingham). 10, *Formicapis clypeata* Sladen. 11, *Chelostomopsis rubifloris* (Cockerell). 12, *Ashmeadiella timberlakei* Michener. 13, *Osmia lignaria* Say. 14. *Stenosmia flavicornis* (Morawitz). 15, *Anthocopa triodonta* (Cockerell). 16, *Prochelostoma philadelphi* (Robertson). 17, *Chelostoma californicum* Cresson. 18, *Robertsonella simplex* (Cresson). 19, *Hoplitis pilosifrons* (Cresson). 20, *Proteriades semiruber* (Cockerell). 21, *Hoplitis albifrons* (Kirby).

Fungus Gnats from the Southern Appalachians—I.*

Frank Shaw

In June, 1939, Dr. C. P. Alexander and party collected in the Southern Appalachians. Most of the collections were made in the Great Smokies but some material was taken on Mt. Mitchell and at Linville Falls, North Carolina. When the insects were identified some nineteen described species in nine genera wre found. Th list of identifications will appear in the Bulletin of the Brooklyn Entomological Society.

In addition there proved to be nine species which are herewith described.

Platyura alexanderi n. sp.

Length 4½ mm.

Head. Median portion of occiput dark brown, lateral portions light brown. Mouthparts and basal two segments of antennae yellow. Remainder of antennae dark brown.

Thorax. Mesonotum, scutellum and postnotum brownish yellow. Postnotum hairy. Pleurae and legs yellow, tarsi infuscated. Basitarsus of prothoracic leg about $^1/_9$ shorter than its tibia. Wing. Length 3½ mm. Hyaline except for a narrow apical brown band. Sc_1 ends about its own length proximad of the fork of Rs. Sc_2 present. Fused portion of M $^5/_6$ as long as its petiole. R_1 is oblique to R_5. Anal vein incomplete.

Abdomen. Segment one yellow. Segment two brown with a narrow, median, yellow stripe. Segments three through five have anterior halves brown, posterior halves yellow. Remainer of abdomen brown. Hypopygium Fig. 1.

This species would run to *Platyura genualis* in Fisher's key. The dististyles of *alexanderi* are wholly distinct from those of *genualis*.

Described from one male collected at the Chimneys, June 5, 1939, at an altitude of 2700 feet by C. P. Alexander. Type in my collection.

I take pleasure in naming this species for Dr. C. P. Alexander who is responsible for my interest in this group of insects.

Platyura mitchellensis n. sp.

Length 5 mm.

Head. Brown, ocellar spot black. Palpi and basal two segments of antennae yellow. Remainder of antennae dark brown.

Thorax. Mesonotum ochreous-rubescent. A faint longitudinal stripe above

* Contribution from the Department of Entomology, Massachusetts State College, Amherst, Massachusetts.

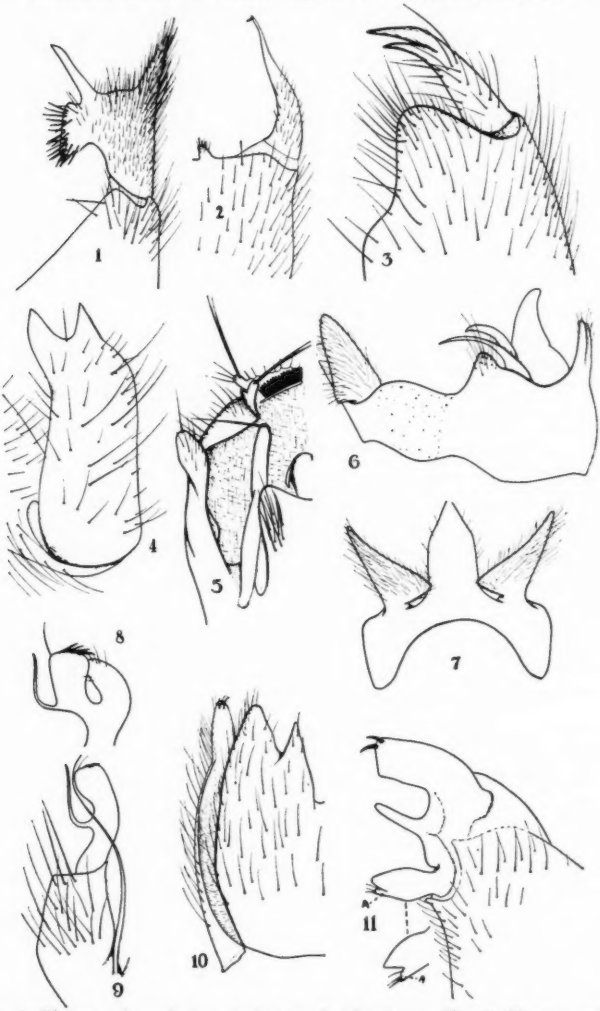


Fig. 1. *Platyura alexanderi*, ventral view of right clasper. Fig. 2. *Platyura mitchellensis*, *dorsal* view of left clasper. Fig. 3. *Platyura miriamae*, ventral view of right clasper. Fig. 4. *Macrocera hyalipennis*, lateral view of right clasper. Fig. 5. *Mycomia sphagnicola*, ventral view of left half of the hypopygium. Fig. 6. *Mycomia triacantha*, lateral view of hypopygium. Fig. 7. *Mycomyia triacantha*, dorsal aspect of tergite. Fig. 8. *Mycomia sublittoralis*, lateral view left clasper. Fig. 9. *Mycomia sublittoralis*, ventral view left clasper. Fig. 10. *Neuratelia insignifica*, ventral view of left half of the hypopygium. Fig. 11. *Neuratelia scituloides*, lateral view of left clasper. Drawings by J. F. Hanson.

the base of each wing. Remainder of the thorax ochreous Metanotum with bristles.

Wing. Length 4½ mm. Hyaline except for a narrow, terminal, light brown band. Sc_1 ends about the length of R_4 before the base of Rs. Sc_2 present. R_4 distinctly oblique to R_5. Fused portion of M subequal to the petiole.

Legs yellow, infuscated at tips. Basitarsus of prothoracic leg about ⅛ longer than its tibia.

Abdomen. First segment ochreous-tubescent. Segments two through five of same color but each has a dark brown anterior margin. Remainder of abdomen including hypopygium brown. Hypopygium Fig. 2.

In Fisher's key this insect would run to *Platyura discoloria*. It can be distinguished from *discoloria* by the shape of the hypopygium.

Described from one specimen taken on Bald Knob, Mitchell Range, June 22, 1939, at an altitude of 5200 feet by C. P. Alexander. Type in my collection.

Platyura miriamae n. sp.

Length 6½ mm.

Head brown. Front and basal two segments of antennae yellow. Remainder of antennae and palpi dark brown to black.

Thorax. Mesonotum yellow with brown stripes. A brown stripe above each wing. These join a median brown stripe. Median stripe extends from anterior margin of mesonotum to scutellum. The median band encloses two yellow areas about the middle of the mesonotum. Humeri are yellow. Scutellum yellow at base, outer margin brown. Metanotum with a brown triangular area having its base next to the scutellum. Pleurae yellow, a brown spot on the anepisternite. Hypopleurae brown.

Wing 5½ mm. long. Tip of wing from origin of R_4 to distal margin broadly banded with brown. A brown spot also above the separation of M from R_{4+5}. Sc_1 ends opposite the forking of Rs from R. Sc_2 present.

Legs yellow, darker toward their tips. Tibial spurs black. Basitarsus of prothoracic leg 1/5 longer than its tibia.

Abdomen. First segment brown. Segments two through four yellow with posterior brown band. Segment five brown with two yellow spots at base. Remainder of abdomen brown. Hypopygium Fig. 3 resembles that of *P. bidentata* Fisher.

In Fisher's key this species would run to *Platyura discoloria*. It can be readily distinguished from *discoloria* by the structure of the dististyles of the hypopygium.

Described from one specimen taken at Linnville Falls, North Carolina, June 13, 1939, at an altitude of 3200 feet by C. P. Alexander. Type in my collection.

I take pleasure in naming this species for my wife Miriam Morse Shaw.

Macrocera hyalipennis n. sp.

Length 4 mm.

Head. Dark brown. Palpi and basal two segments of antennae brownish yellow.

Thorax. Mesonotum dark brown, a yellowish brown stripe above each wing. Pronotum yellow, the remainder of the thorax dark brown.

Wing. Length 3 mm. Hyaline. Costa produced about $^3/_7$ of the distance from R_5 to M_{1+2}. Sc_1 ends in C about the length of R_4 beyond the origin of Rs. R_4 about as long as the petiole of M.

Legs. Coxae, trochanters, prothoracic and mesothoracic femora yellow. Metathoracic femora yellow with brown tip. Tibiae and tarsi appear brown because of the presence of the setulae. Prothoracic basitarsus about $^3/_7$ as long as its tibia.

Abdomen. Somewhat variable in color. Some individuals are uniformly dark brown, others have segments two through five brown with light ochreous posterior margins. Hypopygium Fig. 4 dark brown.

In Johannsen's key this species would run to *immaculata*. It differs from *immaculata* in the structure of the dististyles of the hypopygium.

Described from 4 males from the following locations: Cade's Cove, Tennessee, June 10, at 2200 ft. by C. P. Alexander. Greenbriar Cove, Tennessee, June 15, by W. A. Harrison. Chimneys Camp, Tennessee, June 18, by W. A. Harrison. Clingsmans Dome, North Carolina, June 18, at 6400 ft. by C. P. Alexander. Types and paratypes in my collection.

Mycomyia sphagnicola n. sp.

Length 6 mm.

Head. Dark brown except palpi, basal two segments and about half of the third segment of the antennae which are brownish yellow.

Thorax. Mesonotum dusky yellow with one median and two lateral light brown stripes. Scutellum dusky yellow with 4 marginal setae. Pleurae dusky yellow. Wing 5 mm. long. Sc_1 ends in the costa about opposite the middle of cell R_1. Sc_2 ends in R_1 before the middle of the cell. Petiole of M $^3/_5$ as long as M_3. Cu forks about the length of the r-m cross vein before this crossvein.

Legs. Coxae yellow tarsi appear darker because of setulae. Trochanters with a black stripe on the inner anterior margin. Prothoracic legs missing. Mesothoracic coxae lack spurs.

Abdomen. Segments one through five brown with a narrow posterior yellow band. Remainder of abdomen uniformly dark brown. Hypopygium Figure 5.

In Fisher's key this species would run to *M. flavohirta* Coq. It can be separated from *flavohirta* by the comparative length of the petiole of M and M_3.

Described from one male collected on Andrews Bald, North Carolina, June 11, 1939, by C. P. Alexander. Type in my collection.

Mycomyia sublittoralis n. sp.

Length 4 mm.

Head. Dark brown. Palpi and basal two segments of antennae yellow. Remainder of antennae dark brown.

Thorax. Mesonotum yellow with one median and two lateral brown stripes. Humeri yellow. Scutellum yellow with 4 marginal setae.

Wing 3 mm. long. Sc ends in R_1 about the middle of cell R_1. Petiole of M about twice as long as M_3. Cu froks beyond the end of Sc.

Legs yellow. Prothoracic basitarsus $^4/_5$ as long as its tibia. Mesothoracic coxae without spurs.

Abdomen uniformly dark brown. Hypopygium figures 8 and 9 resembles that of *Mycomyia littoralis* Say.

This species resembles *Mycomyia littoralis*. It can be distinguished by the structure of the dististyles.

Described from one male collected on June 21, 1939, at Linville Falls, North Carolina, at an altitude of 3200 feet by C. P. Alexander. Type in my collection.

Mycomyia triacantha n. sp.

Length 5½ mm.

Head. Dark brown, palpi, basal three segments of antennae and part of fourth brownish yellow. Remainder of antennae dark brown.

Thorax brown, large humeral area yellow. Scutellum brown with four marginal setae. Pleurae yellow, katepisternite with a brown spot.

Wing 4½ mm. long. Sc ends in R_1 beyond the origin of R(s). Petiole of M about $^4/_5$ as long as M_3. Cu forks before the r-m crossvein. Halteres yellow.

Legs. Coxae yellow, trochanters have brown stripes along the inner and outer lower margins. Femora and tibiae yellow. Tarsi appear brown because of setulae. Middle coxae have long curved spurs. Prothoracic tibia $^4/_5$ as long as its basi tarsus.

Abdomen dark brown. Dorsally, ventral region yellow. Hypopygium, figures 6 and 7 dark brown, resembles that of *Mycomyia echinata* Fisher but differs in the structure of the dorsal part of the hypopygium.

In Fisher's key this species would run to *Mycomyia sequax* but can be distinguished from this species by the structure of the hypopygium.

Described from one male taken June 10, 1939, in the Great Smokies at an altitude of 5500 feet. Type in my collection.

Neuratelia insignifica n. sp.

Length 4½ mm.

Head dark brown except for basal two segments of antennae which are yellow.

Thorax dark brown. Halteres yellow.

Wing 4 mm. long.

Legs yellow except for trochanters which are dark brown. Basitarsus of prothoracic leg about 1/4 longer than its tibia. Hypopygium, figure 10, dark brown.

In Fisher's key this species would run to *Neuratelia silvatica*. It is easily separated by the structure of the hypopygium.

Described from one male collected on Siler's Trail, June 6, 1939, at an altitude of 6000 feet by C. P. Alexander. Type in my collection.

Neuratelia scituloides n. sp.

Length 5 mm.

Head. Dark brown except for mouth parts and basal two segments of antennae.

Thorax. Varies from a yellowish brown to dark brown in color. Some individuals have a faint brown stripe over the base of the wings, others have a distinct stripe. Pleurae yellowish brown to dark brown.

Wing 4 mm. long.

Legs. Coxae yellowish to light orange in color. Trochanters dark brown. Basitarsus of prothoracic leg not over 3/5 as long as its tibia.

Abdomen. First segment dark brown. Segments two through five yellow at anterior border and along sides. A large subtriangular brown spot is on each of these segments. Remainder of abdomen dark brown. Hypopygium figure 11 resembles that of *Neuratelia scitula*. It differs from *scitula* in that the process "A" is about twice as long in scitula as in this species. This species seems to be somewhat variable in color. Some individuals are much darker than others.

In Fisher's key this species would run to *eminens* Joh. which was described from a female from Idaho. My species differ from *eminens* in the proportions of the basitarsus to the tibia and in markings.

Described from 3 specimens taken by C. P. Alexander at Little River, Tennessee, on June 10, 1939, at Cade's Cove at an altitude of 2100 feet on June 10 and on Clingmans Dome, North Carolina, June 18, 1939, at an altitude of 6400 feet. Types in my collection. One paratype in collection at Massachusetts State College.

Records and Descriptions of North American Plecoptera

Part I. New Species of Leuctra of the Eastern United States*

John F. Hanson

For the privilege of describing three of the four following new species I am indebted to Dr. C. P. Alexander who collected them during a recent trip to Mount Mitchell and the Great Smoky Mountains of the southeastern United States. These species are closely related to two other species which I have recently described that were collected by Dr. Inez W. Williams in this same very interesting region. One of the species, *Leuctra maria,* was collected while I was on a trip into New Hampshire and Maine with my wife who has accompanied me on many collecting trips.

A detailed general account of each species is omitted from the following descriptions, being quite superfluous because of the fact that the numerous species in the genus are virtually alike in color (uniform medium brown), size, and structure. Excellent specific characters are presented in the terminal abdominal structures.

Holotypes and allotypes of all except *L. maria* n. sp. are deposited in the Massachusetts State College Collection in Amherst. Most of the paratypes are deposited in my personal collection. Male paratypes of *L. nephophila* n. sp., however, are deposited also in the Massachusetts State College Collection, in the Museum of Comparative Zoology in Cambridge, and in the collection of the Illinois Natural History Survey.

Leuctra maria n. sp.

Figs. 1A, 1B, 1C, 1D

Length of body in both sexes, 5 to 7 mm.; of fore wings, 6 to 7 mm.

Male: Sclerotized process of the eighth tergite about one-third the width of the abdomen, extending nearly to posterior margin of the eighth segment, narrowing slightly toward the bilobed apex the lobes of which are small. Ventral lobe of ninth sternite clavate, nearly twice as long as wide, setiferous. Terminal lobe of ninth sternite tiny, amounting only to a small button hardly as broad as the ventral lobe. Subanal lobes, in lateral view, markedly short and broad, apex sharply pointed; in ventral view broad and with a deep trough extending from midlength to the sharply pointed apex. Titillators broad,

* Contribution from the Department of Entomology, Massachusetts State College, Amherst, Massachusetts.

extending slightly beyond apices of subanal lobes, gently curved upward and gradually narrowing to a blunt apex.

Female: Subgenital plate broad, with a deep meso-apical notch dividing the plate into two subtruncate lobes. Each of these lobes in the allotype specimen has apically a darker rim, while the paratype has a rim lighter in color than the rest of the sternite. Seventh abdominal sternite of allotype with a distinct triangular dark brown patch.

Holotype, male. — Barrington, New Hampshire, June 17, 1939 (J. F. Hanson). Allotopotype, female. Paratopotypes. 1 male, 1 female.

This species is affectionately dedicated to my wife, Marie Hanson, to whom I express my thanks for her invaluable assistance.

The trough in the subanal lobes of the male of this species serves definitely to distinguish it from all other described species of *Leuctra* of North America. It is also distinguishable by the character of the process on the eighth abdominal tergite. The apical lobes of this process are considerably smaller than those in other species of *Leuctra* that have a bilobed process on this segment, except *L. mitchellensis* which differs in other respects mentioned in the discussion under that species.

Leuctra alexanderi n. sp.

Figs. 2A, 2B, 2C

Length of body, of male 4 to 5 mm., of female 6 mm.; length of fore wing, of male 5.5 mm., of female 6.5 mm.

Male: Process of the eighth tergite about one-third the width of the segment, extending posteriorly only slightly beyond the middle of the segment; apex consisting of two broad diverging lobes or having only a very slight emargination. Ventral lobe of ninth sternite clavate, twice as wide as long, setiferous. Terminal lobe of ninth sternite about one-half the width of the segment, semicircular. Subanal lobes, in lateral view, curved slightly upward, broadest in the middle, a few spinulae on lower margin near apex, apex blunt; slender in ventral view. Titillators as long as subanal lobes, slender, tapering only slightly, curved ventrad near base and dorsad near apex.

Female: Subgenital plate with a shallow emargination on posterior edge; widening behind toward the apex.

Holotype, male. — Small stream along the Over-the-Mountain Highway near Anakeesta Ridge, Great Smoky Mountains, Tennessee, altitude 4,500 feet, June 6, 1939 (C. P. Alexander). Allotopotype, female. Paratypes. — Anakeesta Ridge, Gr. Smoky Mts., Tenn., alt. 4,000 feet, 1 male, June 5, 1939 (Alexander). Hogback stream, Shenandoah National Park, Virginia, alt. 3,300 feet, 1 male, May 31, 1940 (Alexander).

The process of the eighth abdominal tergite of the male most closely

resembles that of *L. monticola* Hanson but is much smaller and the emargination at the apex is not as deep as in *L. monticola*. The titillators in being recurved are distinctive also.

Leuctra nephophila n. sp.

Figs. 3A, 3B, 3C

Length of body, of male 6 to 7 mm., of female 7 to 8 mm.; length of fore wing, of male 6 to 7 mm., of female 7 to 8 mm.

Male: Process of the eighth tergite well scleritized, about one-fourth the width of the segment, extending posteriorly slightly beyond the middle of the segment, widening toward the apex from a pair of "shoulders" at midlength to a truncate or subtruncate apex. Ventral lobe of ninth sternite clavate, twice as wide as long, setiferous. Terminal lobe of ninth sternite about one-fourth the width of the segment, semicircular. Subanal lobes, in lateral view, very broad, angulate near middle of lower margin, apex sharply pointed; in ventral view, narrow. Titillators about as long as subanal lobes, moderately broad, tapering to a sharp apex, curved dorsad considerably.

Female: Subgenital plate variable, rectangular or narrowing very slightly posteriorly, darker brown apically and mesally in well sclerotized specimens; posterior margin with a shallow mesal notch or a membranization separating two truncate or subtruncate lobes.

Holotype, male. — Andrews Bald, Gr. Smoky Mts., North Carolina, alt. 5,860 feet, June 11, 1939 (Alexander). Allotopotype, female. Paratopotypes. — 8 males, 5 females. Paratypes. — Forney Ridge, Gr. Smoky Mts., N. C., alt. 6,000 feet, 1 male, 2 females, June 18, 1940 (Alexander). Ramsey Cascade, Tenn., alt. 4,000 feet, 1 male, June 21, 1940 (Alexander). Gr. Smoky Mts., Tenn., alt. 4,000 feet, 1 male, June 5, 1939 (Alexander).

The specific name, *nephophila*, is an allusion to the Great Smoky Mountains.

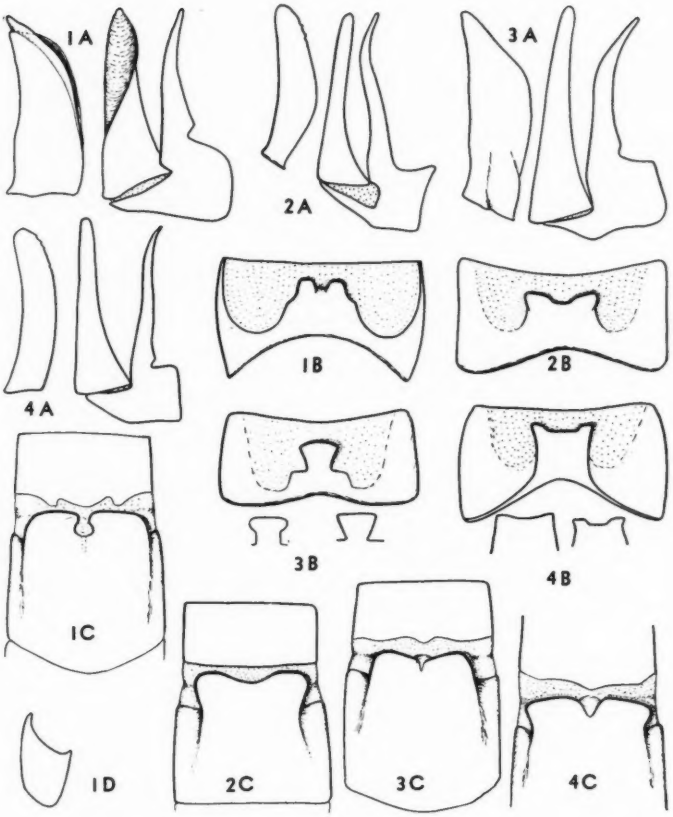
This species differs from *L. truncata* Clsn. in that the process of the eighth abdominal tergite widens rather than narrows, posteriorly. It differs from *L. alexanderi* n. sp. and *L. mitchellensis* n. sp., which sometimes have this process nearly truncate, in that the process is not broad. It differs also in genitalic features as shown in the figures.

Leuctra mitchellensis n. sp.

Figs. 4A, 4B, 4C

Length of body, of male 6 to 7 mm., of female 6 to 8 mm.; length of fore wing, of male 6 to 7 mm., of female 7 mm.

Male: Sclerotized projection of the eighth abdominal tergite about one-third the width of the segment, extending nearly to the posterior margin of



The figures are drawn from slides made of the holotype and allotype specimens. Additional outlines are included where of value in showing variations of diagnostic structures among paratypes.

Numbers refer to the species, and capital letters refer to the various structures shown, as indicated.

1. *Leuctra maria* n. sp.; 2. *L. alexanderi* n. sp.; 3. *L. nephophila* n. sp.; 4. *L. mitchellensis* n. sp. A. Lateral view of titillator and ventral and mesal view of subanal lobe of male; B. Eighth tergite of male; C. Eighth and ninth sternite of female; D. Cross-section of subanal lobe of male at midlength.

the segment, usually parallel-sided or nearly so, and bearing two small latero-apical lobes which are two or three times narrower than the intervening emargination; in one case the latero-apical lobes nearly disappear so as to make the apex of the process almost truncate. Ventral lobe of ninth sternite clavate, nearly twice as long as wide, setiferous. Terminal lobe of ninth sternite one-half the width of the segment, not quite semicircular in shape. Subanal lobes, in lateral view, curved slightly upward, of uniform width throughout its length, a few spinules on lower margin near apex sometimes evident, apex blunt; narrow in ventral view. Titillators as long as subanal lobes, slender, tapering to a sharp point, straight or curved slightly upward, with an abrupt shoulder at the base.

Female: Subgenital plate deeply notched by a V-shaped emargination to form two transversely truncate or subtruncate (obliquely or transversely) diverging lobes.

Holotype, male. — Bald Knob Ranger Station, Toe River Gap, Mt. Mitchell, N. C., alt. 5,200 feet. Allotopotype, female. Paratopotypes, — 4 males, 2 females.

This species differs from its most closely related allies in the large broad process with the small latero-apical lobes on its eighth abdominal tergite. Only *L. maria* n. sp. has such small lobes and in that species the process is much smaller apically and has the lobes closer together than in *L. mitchellensis*. The genitalia of the male closely resembles that of *L. alexanderi* but differs particularly in the width of the basal process of the titillator extending under the subanal lobe.

Studies of North American Solpugida

II. A Second Species of Solpugid from Nebraska

Edson Fichter

It has been shown (Fichter, 1940b) that the solpugid *Eremobates pallipes* ♂ of Simon (1879), Kraepelin (1901) and Roewer (1934), having apparently been mistakenly regarded as conspecific with their *E. pallipes* ♀, was an unnamed species for which has been proposed (Fichter, 1940a) the name *Eremobates palpisetulosus*.

In the course of 9 years (1932 to 1940, inclusive) 59 specimens of Solpugida from Nebraska have been acquired by the Department of Entomology of the University of Nebraska. Of these 59 specimens, 57 (48 ♀, 9 ♂) are *E. pallipes* (Say). The remaining 2 specimens, both ♂ ♂, conform, for the most part, to the *pallipes* ♂ of authors; they therefore comprise the basis for the 2 figures and the description of *Eremobates palpisetulosus* presented in this paper, the species being considered under its own identity.

The evidence at hand indicates (1) that *pallipes* and *palpisetulosus* may and do occur in the same localities, a situation possibly contributing to the above mentioned misinterpretation of the species-sex relationships, (2) that these 2 species constitute the solpugid fauna of Nebraska, and (3) that *pallipes* is the more abundant and widespread of the 2 species in the state, or more commonly observed and captured.

Eremobates palisetulosus

Male. (Fig. 1).

Straw-colored or light-buff, the trunks of the chelicerae deeper buff, lateral surface of pedipalps and legs paler, the latter fading to white distally, except leg IV of which the femur deepens distally and the tibia proximally to a smoky buff. Chelicerae reddish, the dorsal fingers darker than the ventral. Metatarsus of pedipalp becoming smoky-brown distally, tarsus smoky-brown with tip paling to whitish. Eye tubercle dark brown to black. Last two tergites of prosoma* and abdomen dusty-brown dorsally, the latter pale beneath.

Fixed dorsal and movable ventral fingers of chelicera of equal length. Dorsal finger and trunk of approximately equal length as viewed from above. Dorsal finger nearly straight, as viewed laterally, tip only slightly down-curving, somewhat enlarged at the base, with a low, inconspicuous, obtuse protuberance dorso-laterally upon enlarged portion. Dorsal finger with a conspicuous longitudinal groove on median face, tending ventrally near distal end. A single, flat bristle of the flagellum complex fits into this groove. Space between base

* Terminology of Roewer, 1934.

of dorsal finger and first tooth of fond nearly equal to depth of dorsal finger at base. Ventral finger curved upward, with the ventral outline clearly bent in about $^1/_3$ of its length from the tip, the dorsal edge immediately above and slightly posteriad to this bend with an obtuse protuberance.

Dorsal finger without teeth. Fond with 4 teeth in the lateral series, the first of which is the largest, the other 3 successively smaller, the fourth very small; the median series with 4 teeth of which the first is largest, the third next largest, the second next to the smallest, and the fourth the smallest. Ventral finger with one large main tooth at the anterior base of which is a very small intermediate tooth directed forward, both within the proximal half. (Fig. 2).

Pedipalp same length as body; femur, tibia, and tarsus-metatarsus of equal length (8 mm.) and slightly tapering proximally. Tibia of pedipalp with 3 or 4 obvious, slender, amber spines (much like those on trunk of chelicera) on median ventral surface plus 4 shorter, weaker spines, all within the proximal $^3/_5$; femur with 3 obvious, slender, amber spines in slightly spiralled row plus 5 weaker spines, all near distal end; metatarsus and tarsus of pedipalp armed on the median ventral surface with numerous short, robust, truncate, amber hairs; metatarsus without papillae. All of pedipalp with many fine, pale hairs of unequal length, some very long, especially on the tibia and metatarsus.

Tibia II with 1 (?) small terminal spine dorso-posteriad. Tibia III with 1 small terminal spine as on tibia II, plus 2 weaker spines proximal and posteriad to it.

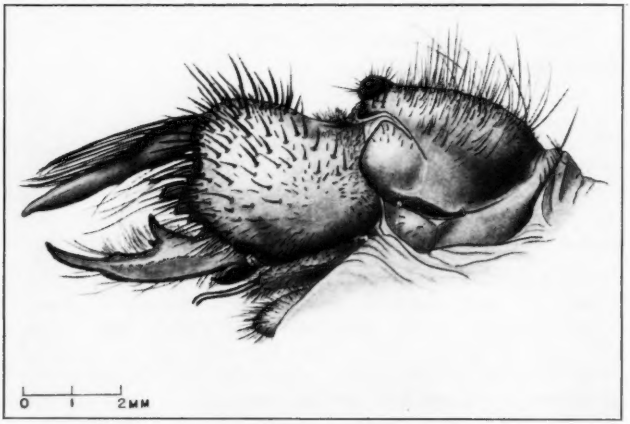


Fig. 1. *Eremobates palpisetulosus*. Male, left lateral view of left chelicera and anterior portion of prosoma. Pedipalps and legs I and II not shown. Drawn from a preserved specimen.

Body length, 24 mm.

Specimens examined. — Two ♂ ♂ received from the following Nebraska localities and collectors: Banner County — Harrisburg, 6-16-1939, 1 ♂ (V. C. Jacobson). Cheyenne County — Sidney, 7-9-1938, 1 ♂ (J. C. Swinbank).

This study was conducted under the direction of the late Prof. Myron H. Swenk of the Department of Entomology, University of Nebraska.

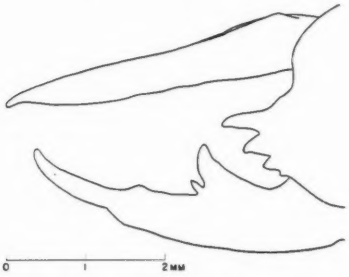


Fig. 2. *Eremobates palpisetulosus*. Male, left lateral view of left chelicera showing pattern of dentition.

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Nests and Behavior of Lepomis gibbosus (Linnaeus) in Lincoln Pond, Rensselaerville, New York

William Marcus Ingram and Eugene Pleasants Odum

Introduction

Lincoln Pond, situated on The Edmund Niles Huyck Preserve, Rensselaerville, Albany County, New York, offers an interesting habitat in which to study the nests and habits of the common sunfish, *Lepomis gibbosus* (Linnaeus). Fishing in this pond has been on a restricted basis for the last 20 to 30 years, thus allowing the sunfish to adapt themselves to natural ecological conditions without any great interference. The land surrounding the pond is a wildlife sanctuary, so that unnatural disturbances of its shores are not transmitted to the water. The study was facilitated by the absence from the pond of Centrarchids other than the above, thus eliminating the possibility of confusion of nests of *Lepomis* with those of other nest builders. The included observations were made from May 20 to September 1, 1940.

The observations embodied here were made possible through a research fellowship awarded the senior author by the Scientific Advisory Committee of the Edmund Niles Huyck Preserve for the period of June 15 to September 1, 1940. The junior author served as resident naturalist from August 1939 to September 1940.

The information included in this paper will supplement the observations and literature summary of Breder (1936), the observations of Abbott (1884), Reighard (1902), Gill (1907), Hankinson (1908 and 1909), Leathers (1911), Wright and Allen (1913), Krecker (1916), Myers (1921), Breder (1926), Adams and Hankinson (1928), Breder and Redmond (1929), Noble (1934), Bailey and Lagler (1938), Carbine (1939), and others on the natural history of the common sunfish.

Description of Lincoln Pond

Lincoln pond, encompassing approximately 9.8 acres, has an average depth of about 5 feet, with a maximum depth of 11 feet. The shore water is shallow, varying in depth from several inches to two feet over an under-water shelf which varies from 5 to 200 feet in width. *Lepomis* apparently restricts its nest building activities to this shelf, never nesting in the deeper water. The character of the bottom of the shelf varies in different parts of the pond, but consists typically of silt carried into the pond from the surrounding land, small flat rocks, water-carried pebbles, and sticks.

The aquatic plants of both emergent and immergent types thrive extremely well in the pond waters, together with accumulated floating masses of *Spirogyra* and other filamentous algae which increased in bulk as the season prog-

ressed. The native emergent plants are *Glyceria borealis, Glyceria grandis, Sagittaria latifolia, Equisetum fulviatile, Sparganium angustifolium, Typha latifolia,* and *Scirpus rubrotinctus.* Of these *Glyceria borealis, Glyceria grandis, Equisetum* and *Sagittaria* are the dominants. In addition, *Zizania aquatica* has been planted in the pond and occurs commonly mixed with the *Glyceria.* Of the submergent plants *Elodea* and *Nitella* are dominant.

Vertebrates Associated with Lepomis

The fish fauna associates in the pond are *Ameiurus n. nebulosus* (Le Suer), *Esox niger* LeSuer, *Notemigonus crysoleucas crysoleucas* (Mitchill), and *Perca flavescens* (Mitchill).

Of the various amphibia in the pond the newt, *Triturus v. viridescens* (Rafinesque) is the most abundant. Next to it in abundance are the green frog, *Rana clamitans* Latreille, and the bullfrog, *Rana catesbeiana* Shaw. The American toad, *Bufo americanus* Holbrook, is a nightly visitor to the shoreline of the pond. Only one mammal, *Ondatra zibethica zibethica* (Linnaeus) inhabits the pond, being restricted to the north end where the underwater shelf is especially extensive. Among the reptiles, *Chrysemys picta picta* (Schneider) is a regular inhabitant of the pond, although not abundant. A large individual of *Chelydra serpentina* (Linnaeus) was observed once.

Reproductive Season

The males were first noticed coming into shallow water to construct their nests on May 20, twenty days after the last ice had disappeared. The females were observed spawning with the males from June 15 to July 17, although spawning possibly began at an earlier date than that indicated. The males began to desert the nests on July 28, and by August 3 all nests had been abandoned. For from 2 to 3 weeks after leaving the nests at the conclusion of the breeding season, sunfish of both sexes were observed in schools of from 5 to 8 in 3 feet of water. After this period rowboat observations indicated that the sunfish generally traveled individually or in twos or threes, and seemed to prefer the deeper water of the pond (over 3 feet). Those found in shallower water were usually observed at the outer edge of the emergent plant zone.

Number of Nests and Breeding Population

A total of 188 nests were counted during the height of the breeding season. Counts were made in early July in the following manner: The shelf zone was divided into sections which had recognizable boundaries. Each section was carefully censused with the aid of a rowboat, one person locating the nests and the other recording them. Only nests being actively guarded by the male were counted. Since deserted nests become obscured by sediment within a few days after their abandonment, inhabited nests could be recognized by their clean appearance even though the guarding male may have been frightened away. The width of the zone of emergent plants was measured at several points and outlined on a base map of the pond. By the use of a planimeter the area of the emergent plant zone was calculated to be 161,172 square feet, or 3.7 acres. The 157 nests located within this zone indicates a nest density of 1

nest to 1,026 square feet, or approximately 42 nests per acre of breeding ground.

The nest count showed that at least 188 breeding male sunfish were present in the pond. As described later a single nest may be guarded successively by more than one male during the breeding season. The sex ratio of sunfish in the pond is not known; in one case two females spawned with a single male. Therefore, until the ratio of number of nests to number of males, and the sex ratio, are more accurately known the breeding population can not be safely figured from nest counts alone. However, it seems safe to assume that the breeding population was at least 376 sunfish.

The Nest

Lincoln pond affords an especially excellent habitat in which to study various nesting situations and nest types of *Lepomis*. Variation in the overhang of trees, variation in the type of bottom in different areas around the shore, and variation in plant density offer an interesting opportunity for observing areas of preference and areas shunned by the male sunfish.

The majority of the nests were constructed within the emergent plant zone. Of the 188 nests, 157 were within the emergent zone and 31 were built in the deeper water within the zone of submergent plants. A zone of *Equisetum fluviatile* extends into the pond approximately 200 feet at the northern end; this was the only emergent plant noticeably shunned by the sunfish. Only 12 nests were situated within the borders of this zone, and of these none penetrated the *Equisetum* zone more than 10 feet. The remaining 145 emergent zone nests were surrounded or abutted with *Glyceria, Sparganum,* or *Sagittaria* in fairly pure stands, or by a mixture of these plants. The density of the *Equisetum,* and consequent inability of the sunfish to root up the plants in constructing the nest, offers a possible reason for the general avoidance of the *Equisetum* zone by nesting males. The character of the bottom was apparently not a factor in the avoidance of this zone, for marginal nests were present, and the bottom over which the *Equisetum* layer was formed was essentially that of the most dense nesting localities.

It was found that bottom areas in total shade were usually avoided. Eighty-five of the nests were in areas of tree overhang, exposed to the sun a part of the day, shaded the rest of the time, while 103 were in areas as open to penetration by the sun's rays at all hours of the day. However, three nests in Lincoln Pond were constructed on mud bottom, directly beneath the alders overhanging the water on the southwest shore. These nests, well in toward the bank, were shaded from direct penetration of the sunlight throughout the day. One had, in addition, a floating cover of dead *Glyceria* which had become entangled in the low hanging alder branches. In spite of this dense shade the guarding male remained on his nest throughout the breeding season.

A number of different types of bottom habitats, varying from mud, gravel, mud and sticks, mud and small flat shale rocks, rounded stream-carried pebbles and sticks, and gravel and small flat shale rocks, were available to the sunfish

in Lincoln Pond. The mixture of small flat shale rocks and gravel was utilized for sites of 75 percent of the nests counted. The pure mud bottom areas were those the least used.

Breder (1936) states, "Although sunfish eggs are slightly adhesive, apparently no species will use an inclined or vertical surface. At least there is no record of their ever having done so." Two records of *Lepomis* nests so constructed are now offered. The first of these male fish constructed his nest over a rock slab which was surrounded by *Nitella* and *Elodea*. This slab was tilted at an estimated angle of 25 degrees; no gravel, sticks, or sand were in the nest, its sole bottom being the tilted rock slab. In the other instances under observation a male fish had again chosen a rock slab which formed approximately three-fourths of the nest bottom, the other fourth being gravel. The eggs were attached to the slab at its union with the gravel. The slab tilt was about 30 degrees.

The nests that were on the outer margin of the *Gylceria* and *Sagittaria* emergent plants were constructed in immergent plant associations of *Nitella* and *Elodea*, which abounded in a definite outer zone to that of the emergent plants. Nests that were found here were often completely surrounded by the above immergent plants, which in many cases terminated with their tips floating on the surface of the water. In such instances the guarding males were "cooped up." In order to give the fish a free pass of entrance and escape, channels were noted to have been rooted out. These varied from a few inches to as much as 3 feet in length. The majority of these runs were directed toward deep water. The channels leading from nests were also observed constructed in the *Glyceria-Sagittaria* zones when the nests were deep within this association. The "clean" appearance of these channels indicated that the guarding males kept them open as an added duty to nest protection. The channels varied in breadth from 2 to 4 inches.

For comparison's sake Table 1 has been constructed after essentially the same pattern as that used by Breder (1936), although data were not collected from as many nests, and is therefore not conclusive, but given as indicative of the nesting habits of *Lepomis* in Lincoln Pond. Figures show (Table 1) that in Lincoln Pond the nests examined were more than twice the length of the nesting male. This difference from Breder's observations (1936) is possibly explained by the fact that in Lincoln Pond *Lepomis gibbosus* is not competing with other Centrarchidae such as *Pomoxis*, *Micropterus*, etc., for a nesting site, and consequently does not have to defend the nest against any of its relatives.

Breder (1936) found that *Lepomis gibbosus* at Pines Lake, New Jersey, nested within a depth range of from 0-5 inches; during the period of observations in Lincoln Pond no fish was found to be nesting in water less than 7 inches in depth (Table 1). Breder's figures show that 36% of the nests at Pines Lake that were examined occurred within the 5-10 inch water depth, while the majority in Lincoln Pond are about equally divided between the 10-15 and 15-20 inch depth (Table 1). In addition to those nests whose measurements are included in Table 1, another 45 were measured to determine the water depth over the center of the nest; of these 25 were within the 10-15

inch depth, 15 within the 15-20 inch depth, and 5 within the 7-10 inch depth. In Lincoln Pond there was generally no apparent crowding of nests (Table 1) even in areas of nest abundance. The least distance between nests was 6 inches, and these were separated by a thick layer of *Glyceria*, thus shielding the males from one another.

TABLE 1.—Nesting Data

Nest No.	Water (2) Depth	(2) Nest Rim Diameter	Adjacent to Another Nest	Adjacent to Solid Object	Character of Bottom	Distance from (3) Shore	Size of (2) cupant
1.	7	23 by 16	(1)	None	Flat Rocks & Pebbles	4½	7
2.	7	23 by 28	.....	None	Flat Rocks & Sand	½	5
3.	8	18 by 12	.....	None	Pebbles & Sand	3	4½
4.	8½	27 by 24	.....	None	Mud	2	8
5.	8	20 by 19	3 feet	None	Flat Rocks & Sticks	1	?
6.	9½	28 by 18	.....	Rock	Flat Rocks	3½	8½
7.	11½	30 by 21	.....	None	Flat Rocks	1½	8
8.	11	22 by 27	.....	None	Pebbles	20	?
9.	11	22 by 20	.....	None	Flat Rocks & Sticks	2	?
10.	12	21 by 12	.....	None	Pebbles	6	6
11.	12	18 by 18	.....	None	Flat Rocks	2½	7
12.	12½	26 by 25	.....	Rock	Mud & Pebbles	6	9
13.	13	20 by 22	3 feet	Rock	Sand	1	8½
14.	13	16 by 12	.....	Rock	Flat Rocks	5	?
15.	14½	26 by 26	.....	Rock Slab	Flat Rocks & Sand	20	8
16.	14¾	33 by 18	.....	None	Mud	18	?
17.	15	28 by 24	.....	Rock Slab	Pebbles	30	?
18.	15½	36 by 32	6 inches	Rock Slab	Flat Rocks & Sand	35	10
19.	15½	32 by 30	.....	None	Flat Rocks	20	?
20.	17	24 by 18	12 inches	None	Flat Rocks	2½	8
21.	17½	24 by 18	12 inches	None	Flat Rocks	2½	5
22.	17⅞	20 by 14	.....	Stick & Rock	Flat Rocks	9	5
23.	18	32 by 27	6 inches	None	Flat Rocks	30	8
24.	18½	28 by 24	.....	None	Flat Rocks & Pebbles	4½	7
25.	20	30 by 33	3 feet	None	Flat Rocks & Pebbles	30	8
26.	23	16 by 12	.....	None	Sand	40	6

(1) ..... indicates that neighboring nests are more than 3 feet distant.

(2) Measurement in inches.

(3) Measurement in feet.

Data in Relation to Depth Ranges

Depth Ranges 2	Number of Nests	Per Cent of Nests	Aver. Rim Diameter 2	% Adjacent to another Nest	% Adjacent to Solid Object	Average 1 Dist. from Shore	Average Size 2 Occupant
0-7	0	0	0	0	0	0	0
7-10	6	23.07	23.63 × 19.50	16	16	2.41	6.60
10-15	10	38.40	23.40 × 20.10	10	40	8.20	7.75
15-20	9	34.61	29.33 × 24.44	55	33	18.16	7.42
Over 20	1	3.84	16 × 12	0	0	40	6.00

1 Measurement in feet.

2 Measurement in inches.

Relation of Nesting Males to Other Animals

There seems to be frequent association between male *Lepomis* and *Esox niger* during the period that the male sunfish guards the nest. In Lincoln Pond the pickerel often were observed to come into the shallow water (7-15 inches) both at night and during the day. Two daylight observations indicate that *Lepomis* is capable of defending its nest, or territory, against carnivorous pickerel. A pickerel estimated at about eighteen inches in length was observed to come into the center of one nest while the male sunfish was busily engaged in chasing away golden shiners, *Notemigonus*. The male sunfish, ending his shiner chase, returned to the nest and swam at the pickerel. Although the sunfish did not attain actual contact with the pickerel, the latter swam out of the nest into the bordering *Elodea*. The sunfish did not pursue beyond the nesting area. In the other daylight observation an estimated 18 to 20 inch pickerel swam into the margin of the nest of a guarding sunfish, and remained there 3 minutes until the guarding male fish swam toward the pickerel in giving chase to shiners, whereupon the pickerel moved out into deep water. Three times during night collecting of Bullfrogs and Green frogs pickerel were observed lying within the rims of sunfish nests, with the guarding male fish seemingly oblivious of their presence. Each time the nests were marked and visited the next morning to see whether the sunfish had been eaten by the pickerel, but in each instance the male sunfish was still on his nest. In one of the above observations the pickerel was not more than 4 inches away from the male sunfish. In another, two males guarding a single nest were being observed when a pickerel swam into the nest. The pickerel apparently inadvertently brushed against the smaller of the two male fish, which swam to the border of the nest and rested here with its head toward the nest's center. Here he remained for the 15 minutes that the nest was under obsrvation, during which time the pickerel swam away without further disturbance.

One nest under observation at 11:45 P.M. was entered by a crayfish, *Cambarus*, while the male *Lepomis* was stationary and tilted at a slight angle in a common nightly resting position. The crayfish bumped into the side of the male fish, startling it and sending it to the nest border where it again assumed the described resting position. The crayfish walked through the nest and out into the surrounding *Glyceria*. The sunfish did not return to the center of the nest again during the 30 minutes the nest was under observation.

The golden shiner, *Notemigonus*, seems to be a constant daylight menace to the eggs of *Lepomis*. These small minnows were about every nest in Lincoln Pond, hovering over the guarding males. At every opportunity the shiners darted to the nest bottom to feed on the developing sunfish eggs. As many as 20 shiners have been counted over a single nest, although from 6 to 9 was the average number. The response of the various male sunfish to the minnows seems to vary with the individuals. It was noted that usually the shiners hover above the guarding male; when in this position they are usually ignored by the sunfish, but as soon as one or more drop down to take a position in the water on the level with or beneath the guarding male they are chased to the margin of the nest. One male sunfish chased the shiners away from the nest continual-

ly, even though they remained above him. Eight dashes were made toward the shiners over a period of 5 minutes. Young perch or sunfish 2 or 3 inches long were sometimes in evidence among the shiners, and were treated in the same way by the guarding males.

It seemed to the writers that the attack charge of a guarding male against an intruder followed 3 different patterns. Attack charge one was merely a rapid ellipse around the center of the nest. This motion was used to drive the ever-present golden shiners to the nest margin, or to force them above the guarding male when they became so venturesome as to drop to his level. In this charge no attempt to strike the shiners was ever observed. Attack charge two consisted of a straight line charge at moving objects on the nest margin, usually used against intruders larger than the shiner, such as another sunfish. In this attack charge the guarding male would swim at the intruder in a fairly straight line without seeking body contact, and return from the rim of the nest to its guarding station over the eggs along approximately the same path. Attack charge three was a contact charge, and was made in a straight line toward the intruder, ending in a half circle in retreat after the offending fish had been struck and chased from the nest. The pursued fish was usually struck either behind the operculum, or on the caudal peduncle. This charge was used only when a venturesome fish began to swim toward the center of the nest. One "hit" by the guarding male was always enough, in the observations made, to send the intruder to the nest border or away from the nest into the surrounding water. Offenders, usually other male sunfish or yellow perch, that were struck in such a manner were generally the approximate size of the guarding male sunfish or larger.

In one instance a male sunfish approximately 2 inches smaller than the guarding male was observed apparently feeding on the nest margin. Two chases of the attack one variety were made against the smaller male which swam over the rim of the nest but remained in the vicinity. When it entered the nest for the third time the guarding fish made a direct charge and hit it behind the operculum; therupon the young male swam toward the nest margin, where it remained, but apparently was not disturbed again by the nesting male, nor did it again venture into the nest proper. In another instance a male of approximately the same size as the guarding male entered a nest margin and began to swim toward the center; he was immediately chased away by the straight line charge and bumped behind the operculum, retiring to the bordering *Elodea*. This action pattern was repeated a few minutes later. After fifteen minutes he ventured into the nest a third time, when the charge of the guarding male resulted in a strike an the caudal peduncle. In none of the three attacks did the guarding male *Lepomis* swim over the nest rim. As soon as contact with the intruder was made the watching male would return to the center of the nest and continue his vigil over the eggs, fanning the water with the anal and caudal fins.

Spawning

Although male-female associations were not observed in great detail, an interesting observation involving the spawning of one male with two females

was seen, although spawning did not occur with both at the same time. Two females of approximately equal size were seen in a nest with one male at the same time. The first female to enter the nest darted into the center of the reed and began to circle with the guarding male after the fashion observed by Noble (1934). Biting was mutual during the sexual act. A second female entered the nest as the circling action was taking place and in turn began to circle the spawning fish just within the nest's rim. The male, observing the newcomer, deserted the first female and began to circle with the second, whereupon the first female swam out of the nest.

Response to Weather and to Man

The male fish were active both on warm days and on cool ones, throughout the period of the breeding season. On cool days (water temperature 50-60 degrees Fahrenheit), male fish were observed "mouthing" the bottoms of their nests and giving chase to shiners and to other young fishes. The customary fanning action of the eggs was also carried on with the same vitality as on warm days (water temperature 61-70 degrees Fahrenheit). Too, spawning was observed on the cooler days. Clouds passing over the sky were not observed to frighten the guarding male sunfish in Lincoln Pond, as Breder (1934) noted to be true at Llewellyn Lake. However, when man's shadow was reflected suddenly over the nests a flight response was often observed. Such a response was less often elicited from fish guarding nests around the boat dock where apparently they adapted themselves to man's presence. It was even possible to pass over these nests with a rowboat without frightening the fish from their guarding duties.

During the early summer it was noted that nests were left unguarded during the heavy daylight squalls that sometimes broke suddenly. During the several such brief thunder showers the guarding males were observed leaving their nests to go into the deeper waters of the pond. As soon as the showers ended the males returned to their nests. During daylight light showers, steady rain, and night storms—even sudden downpours such as caused them to leave during the day, the males were observed to stay on their nests. In the areas under observation the predacious golden shiners reacted to daylight, heavy and light showers, and steady rain as did the guarding male sunfish. After heavy daylight showers, during which nests were temporarily abandoned, the male sunfish always returned before the shiners.

Guarding males were not disturbed at night by suddenly flashing rays from a 5-celled flashlight upon them. A total of 30 guarding males were observed on their nests through the use of such a flashlight, and none showed any inclination to leave the nests. The longest continued display of light on a single male was for a period of one hour. These observations are contrary to Breder's (1936). Night observations indicated that the male sunfish rested on the bottom of their nests in one of two different ways; the commoner resting position found the fish tilted sideways at an angle of about 80 degrees, the less frequently encountered resting position was an upright one. Oftentimes the resting males could be touched by hand at night; even though disturbances

were no doubt set up by thrusting one's hand in the water, the fish seldom moved until contact was made on their bodies.

Banding Male Sunfish for Study

In order to facilitate the study of guarding male sunfish, several were banded by using a home-made tin clip which was placed around the first few spines of the first dorsal fin. These clips were about one inch long, and were painted with various colors so that the banded fish could be easily recognized by "spotting" the color or combination of colors on the band. In such studies the colored tag is more useful than a jaw clup which is numbered, necessitating catching the fish to ascertain the number. The fin clips apparently caused no discomfort to the fish, and were readily observed from a rowboat, or when the fish was close in to the shore. Since the guarding males were qeiuscent at night, and were not disturbed by the beam of a flashlight, the fish to be banded were most successfully captured in a seine or hand net during the hours of darkness.

Reclaiming Deserted Nests

On June 18 a guarding male fish was seined from his nest and disposed of, and the nest marked. On June 20 a large male was observed on the deserted nest. This second occupant held claim to the nest until July 15 when he too was removed by a seine and disposed of. On July 20 a third occupant was found on the marked nest, although the only evidence that a nest had been there was the piled-up nest rim which had been constructed by the first occupant. This fish cleared the debris out of the filled-in nest bottom and stood guard until August 1, with the apparent breakup of the breeding season.

One example of nest transference due to a local disturbance was recorded. A dense mass of algae floated over a nest containing eggs, and occupied by a male sunfish; this mass of algae was held in place over the nest by its entanglement with a bordering zone of *Glyceria*. Two days after the algal mass floated over the nest the male constructed another nest one foot away from the site of the first. Since nests shaded throughout the day were found in Lincoln Pond, the desertion of the first nest was probably not due to shading of the algae so much as its crowding action on the sunfish. The fish remained on the second nest for 10 days, from July 13 to July 23. More algae accumulated over the second nest and finally became so dense that the fish was crowded to the outer one-half of the nest. No eggs were found in the second nest. On July 23 this same fish moved 5 feet away to a recently deserted nest and stayed there until August 3 when the breeding season for *Lepomis* in Lincoln Pond finally terminated. Carbine (1939) in his Table I indicates that the common sunfish may use nests other than the original several times during the reproductive season at Deep Lake, Oakland County, Michigan.

In connection with the reclamation of deserted nests the question arises: Do some males mature when the breeding season is well over and come into shallow water to construct their own or to take over deserted nests[1]; are the

1 Dr. Raney's examination of the gonads of males which came into shallow water to construct nests late in the breeding season indicates that some males mature when the breeding season of the general population is well along.

wanderers disappointed males seeking more favorable nesting sites; or is wandering due to a mechanical disturbance of the original nests?

Discussion

The data included here should be thought of as applying only to *Lepomis gibbosus* in Lincoln Pond, Rensselaerville, Albany County, New York, during the observation period. It is obvious from the text that great variations in behavior and habits of the common sunfish exist in Lincoln Pond. No dispute of Breder's (1936) findings are intended; actually we are merely comparing some rather minor details which are probably not in agreement due to differences in local situations studied.

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Summary

1. The reproductive season for *Lepomis gibbosus* in Lincoln Pond, Rensselaerville, Albany County, New York, in 1940 extended from approximately June 15 to July 17.

2. After nest desertion male and female sunfish school in shallow water. After 3 weeks, schooling breaks up and the fish go to deeper water.

3. A nest count showed that 188 breeding male sunfish were in the pond.

4. The majority of nests were constructed within the emergent plant zone. *Equisetum* zones were avoided as nesting sites.

5. Areas of bottom open to penetration by the sun's rays were preferred as nesting sites, although shaded nests were present. Three nests were found that were shaded all day from direct penetration of sunlight.

6. Of the different types of bottom areas available, that of mixed gravel and small flat rocks was preferred.

7. Two nests were found constructed over inclined surfaces, the inclination planes having been approximately 25 and 30 degrees.

8. Nests that were constructed in *Nitella* and *Elodea* zones had runways, apparently made by the guarding male *Lepomis*, that led into deeper water. Runways often existed in conjunction with nests that were constructed within dense *Sagittaria* and *Glyceria* zones.

9. The observed nests were in diameter more than twice the length of the males that were guarding them.

10. None of the observed nests were in water shallower than 7 inches or deeper than 23 inches.

11. The abundance of nests in a given depth was divided about equally between the 10 to 15, and the 15 to 20 inch depths.

12. Conditions of nest crowding did not exist; the closest proximity of one nest to another was 6 inches. The two examples of nests found so close together as this were separated by a luxuriant growth of *Glyceria*.

13. Guarding males seem to be in frequent contact with the numerous pickerel in the pond. In the few observations of these two fish together the sunfish were not moletsed.

14. Guarding male sunfish seem generally to tolerate the presence of numerous golden shiners and other "small fry" which hover about. When the smaller fish were observed to drop to the level of the guarding male sunfish chase was always given.

15. In warding off would-be nest disturbers guarding male *Lepomis* seem to follow three lines of attack: 1. An ellipse charge around the nest without attempted contact with the intruder. 2. a straight line attack and return without bodily contact; and 3. a straight line attack to the body of the intruder ,usually striking the latter just behind the operculum or on the caudal peduncle. The return to the nest's center after such a charge is made in a half-circle.

16. On occasion male sunfish will spawn with 2 females in immediate succession.

17. No noticeable difference was noted in the activity of sunfish on cold days (water temperature 50-60 Fahrenheit), and on warm days (water temperature 61-70 Fahrenheit).

18. The reflection of moving clouds on the water did not frighten guarding male fish. However, when man's shadow was reflected suddenly over the nests a flight response was often observed.

19. Sudden thunder showers during daylight caused guarding males to desert their nests. As soon as such showers were over the males returned. Similar showers during darkness had no effect on guarding males.

20. The guarding males observed at night by flashlight showed no fright response.

21. Combination color bands clipped around the first few anterior spines of the first dorsal fin aided in observations. For such studies a colored band is more useful than a jaw tag.

22. Male sunfish were observed reclaiming deserted nests.

23. Accumulated masses of algae over nests will cause male sunfish to construct nests under more favorable circumstances.

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Relative Numbers of Shallow Water Fishes of the Northern Gulf of Mexico, with Some Records of Rare Fishes from the Texas Coast

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Introduction

Several years ago the writer became interested in the subject of animal numbers, especially the numbers of marine fishes in the shallow waters of the northern part of the United States Gulf Coast. Studies of this subject were published in four papers, Gunter, 1935, 1936, 1938a and 1938b, which were also related to other matters.

Some biologists are critical of studies of animal numbers in nature, holding that such attempts are useless assaults upon a practically chaotic condition. This is a defeatist view. There is probably no disagreement over the difficulty of gathering information and its relative smallness, compared to the amount needed for complete knowledge; but any study of animal numbers is a step in the direction of quantitative evaluation, a concept to which all science is supposed to be dedicated, and, as such, is worthwhile. The concept of living species as species masses of protoplasm of different sizes will lead to better understanding of the economics of life in any environment. The work of the former Bureau of Biological Survey on the numbers of North American migratory waterfowl and its important practical results, stands as an example of the utility of such studies.

Estimates of the absolute numbers of the best-known marine fishes will probably always be qualified by large margins of error. At our present stage of knowledge such an estimate can not be attempted, so we must fall back to relative or comparative numbers of species to species. It is my purpose here to review some points brought out before, to rectify certain errors of interpretation and to mention new facts and points of view.

With respect to relative numbers, there are two types of fishes that are much easier to observe and draw conclusions about than those present in moderate numbers. They are fish that are extremely abundant and those that are very uncommon or extremely rare. These two groups of fishes will be treated separately below, with few remarks on moderately numerous species for the reason that little about them is known.

Less Numerous Fishes

In a note on fishes rarely caught in shrimp trawls on the Louisiana Coast by the Shrimp Investigations staff of the U. S. Bureau of Fisheries (Gunter,

1935), thirty species were listed. They comprised only 0.09 per cent of the catch over a period of two and a half years. These records will be discussed below in the light of additional information gained since that time.

Five of the fishes, *Archosargus probatocephalus* (Walbaum), *Anguilla bostoniensis* Le Sueur (listed as *A. rostrata*), *Menidia peninsulae* (Goode and Bean), and *Mugil cephalus* Linnaeus, were said to be common, but not ordinarily present in open water where the trawls operated. The other species were placed in the category of "truly rare." At least three of them should have been included with the above five species. The pompano, *Trachinotus falcatus* (Linnaeus), and the ten-pounder, *Elops saurus* Linnaeus, are not uncommon. The clingfish, *Gobiesox strumosus* Cope, listed as *G. virgatulus*, is very common on oyster reefs, but rare in open water. For that reason it is nearly always confined to the bays.

The choice of the term "truly rare" was unfortunate. Probably, uncommon or not numerous would have been more correctly expressive of the true situation. It was implied, but should have been emphasized that the term applied only to the presence of fishes in the area considered, the bays and Gulf out to twelve miles offshore, and not to other parts of their range. Doubtless, several species of marine fishes are extremely rare, some of them being on the verge of extinction, but in all probability most fishes listed in that category are so listed because collectors have not collected in the proper place with the proper gear.

The red snapper, *Lutianus blackfordii* Goode and Bean, evidently comes close to shore when small, although the large fish are not known there in Louisiana. Three were recorded from Louisiana and the writer saw two taken six miles out from the mouth of Aransas Pass, Texas, in April, 1940. Mr. J. L. Baughman informed me that he once saw a dozen small snappers taken in a shrimp trawl, twelve to fifteen miles off Galveston. In Louisiana the larger snappers are probably held offshore by the lower salinity or higher turbidity of the inshore waters or both. Fishermen say that during the time of floods, a muddy streak of water may extend out from the Brazos River to the snapper banks, about forty miles offshore, and that as soon as it touches the banks the snappers leave. During fair summer days "when the blue water is in," quoting the fishermen, a few large red snappers are occasionally caught from the jetties at Port Aransas, Texas, which extend out a little less than half a mile from the beach. It should be pointed out that Louisiana inshore waters, due to greater land drainage, are less saline and more murky than Texas inshore waters.

Among the other fish listed as rare in the Louisiana trawl catches, was *Balistes capriscus* Gmelin. It is a very numerous fish on coral reefs and snapper banks in Texas. *Seriola* sp. was uncommon in trawl catches. *Seriola dumerili* (Risso) and *Diplectrum formosus* (Linnaeus) are also fairly common on the snapper banks. The shark-sucker, *Echeneis naucrates* (Linnaeus), is fairly common in Texas offshore waters around the banks, probably due to the greater concentration of the larger fishes to which it attaches. Such specialized

fishes as *Antennarius* sp., *Ophidion* sp., *Monocanthus hispidus* (Linnaeus), *Rhinesomus triqueter* (Linnaeus), and *Ogcocephahalus radiatus* (Mitchell) are probably not very numerous anywhere, but are possibly more common farther offshore than the inshore hauls indicated. I did not take *Ogcocephalus vespertilio* (Linnaeus) in Louisiana, but Mr. Baughman has informed me that on mud bottom, twelve miles or so offshore in Texas he has seen a bushel or so of both batfishes taken in the same trawl haul. *Paratractos chrysos* (Mitchell), and *Caranx latus* Agassiz (listed as *Xurel lata*) are reasonably common in Texas offshore water. Little is known of the relative abundance of *Myrophis punctatus* Lutken, *Hippocampus regulus* Ginsburg, *Epinephulus drummond-hayi* Goode and Bean and *Brachygenys chrysargyreus* (Günther), either inshore or offshore, and the only information at hand is in the records given before. The same thing holds true for the goby, *Dormitator maculatus* (Bloch), but it is probably more common in fresher water.

The elasmobranchs listed: *Pristis pectinatus* Latham, *Pteroplatea micrura* (Schneider) and *Stoasodon narinari* (Euphrasen) are large and are probably never numerous. However, they are not exceedingly uncommon and it is incorrect to call them rare. There are two species of sawfish on the Texas Coast and *Pristis pectinatus* seems to be the least numerous one. The other species is probably *Pristis perrotteti* Valenciennes. *Stoasodon narinari* has been reported to form schools at times, but there is no definite information on that point.

There is no evidence that the barracuda, *Sphyraena guachancho* Cuvier and Valenciennes, is common in this part of its range. One Texas specimen, presumably, since the date and locality is unknown, was in the collection of the Coastal Division of the Texas Game, Fish and Oyster Commission. It has been transferred to Rice Institute. The record from Louisiana, given previously, is the only one from that state known to me. The triple-tail *Lobotes surinamensis* (Bloch), is seldom present in any numbers, Baughman (in press).

The writer is indebted to Mr. J. L. Baughman for several suggestions and for much of the information concerning the abundance of the various fishes on the Texas offshore reefs and banks.

Some Records of Rare Fishes

So far as the writer knows there is no record of the headfish, *Mola mola* (Linnaeus), from either Louisiana or Texas. There is a rather creditable sight record, made in Barataria Pass, Louisiana, in the spring of 1933 by the late Colonel Hu B. Myers. We were on a boat together. He saw a strange fish and was mildly excited by its peculiar appearance. He immediately drew a pencil sketch and showed it to me. It was a crude, but unmistakable, outline of *Mola mola*. Col. Myers said the fish was about a foot long.

There are no published records of the thresher shark, *Alopia vulpinus* (Bonnaterre), from the Texas Coast. It is listed by Cross and Parks (1937), but this check list is a compilation from other sources and is not based on

actual records but on suppositions as to probable geographic range, at least so far as many species are concerned. Springer (1938) lists this shark from Biloxi, Mississippi. About ten years ago a specimen was captured in a beach seine on Mustang Island, three miles from the north end of the island. It was mounted and is now in the shop of Roberts and Brundrett, taxidermists, at Port Aransas, Texas. It measures 165 centimeters in total length.

Parks (1939) has published a record of another uncommon elasmobranch, the monkfish, *Squatina squatina* (Linnaeus), from the Texas Coast. Strangely enough, the paper does not say where or when the specimen was caught. Dr. Parks wrote me that the fish was caught in a shrimp trawl in Corpus Christi Bay during March, 1937. He mounted it and now has it at Nacagdoches, Texas. About twelve years ago a monkfish was taken about five miles offshore from Aranas Pass (the pass proper and not the town of the same name) in a shrimp trawl. It was mounted and is now in the shop of Roberts and Brundrett, at Port Aransas, Texas. It measures 99 centimeters in total length. This is the first specimen reported from the Texas Coast and the second one recorded.

Records of the ladyfish, *Albula vulpes* (Linnaeus), were lacking until the recent one by Baughman (in press).

A fairly common fish in the offshore waters of the Texas Coast, although it is not generally recognized to be so, is the great barracuda *Sphyraena barracuda* (Shaw). There is a mounted specimen in the shop of Roberts and Brundrett in Port Aransas, which was taken from the offshore snapper banks, and other specimens in that town. Mr. Baughman has told me that the fish is fairly common on the offshore banks up and down the coast. A previous record of this species in Texas was given by Johnson (1879).

Abundant Species

In making estimates of the relative numbers of fishes, seasonal variations, the type of environment, and characteristics of the gear used in collecting must all be taken into consideration. These factors, many of them self-evident, have been discussed in the papers cited. The evidence collected by any gear must be subject to extensive qualification.

Another source of information, which has recently forced itself to attention, (Gunter, 1941), is the hard cold waves which strike the northern shores of the Gulf of Mexico every ten or fifteen years, killing vast numbers of fishes. Likewise, any other natural catastrophe which kills large numbers of fishes is a valuable source of information. Data from cold waves are subject to the same qualifications that must be applied to data collected by gear, namely, that there is a differential effect on species, (Storey, 1937; Gunter, *op. cit.*), and possibly a differential effect on the same species at different ages, (Hildebrand and Cable, 1930; Gunter, 1938b, 1941). Also, certain fishes float after death or become apparent more so than others. The writer gave some figures, in the last-mentioned article, above, on the numbers of species killed by the recent freeze in Copano Bay, Texas. The fishes killed in

greatest numbers were the yellowtail, *Bairdiella chrysura* (Lacépède); anchovy, *Anchoviella* sp.; speckled trout, *Cynoscion nebulosus* (Cuvier and Valenciennes); drum, *Pogonias cromis* (Linnaeus); mullet, *Mugil cephalus;* sheephead, *Archosargus probatocephalus;* pinfish, *Lagodon rhomboides* (Linnaeus), and sea cat, *Galeichthys felis* (Linnaeus), in about that order.

Although we are treading on admittedly infirm ground, I shall tentatively rank here the first four fishes of the shallow waters of the northern Gulf of Mexico, from the standpoint of species mass. The criteria for these rankings are data from trawl catches, given before, a small number of seine hauls, data from fishes killed by the freeze of 1940, the commercial catch of the Gulf States and, lastly, general observations over a period of nine years. I have seen to reason to change the conclusion advanced tentatively before (Gunter, 1938a) that an anchovy, *Anchoviella* sp. has the greatest mass of any species of fish on this coast. It was stated that in Louisiana this anchovy was *Anchoviella epsetus* (Cuvier and Valenciennes). However, *Anchoviella mitchelli* (Cuvier and Valenciennes), is very common on the Texas Coast and it is possible that both species are involved, with seasonal or territorial variations up and down the coast. Further data will have to be gathered before a conclusion on this question can be reached. According to Hildebrand and Schroeder (1928), *A. mitchelli* is probably the second most abundant fish in Chesapeake Bay.

Second and third in species mass on the Gulf Coast come the menhaden, *Brevoortia patronus* Goode, and the striped mullet, *Mugil cephalus*, respectively although their order may be reversed. Statistics of the U. S. Fish and Wildlife Service show that the striped mullet is the most important food fish, from the standpoint of both pounds caught and total value, on the South Atlantic and Gulf Coasts. Fourth place in species mass goes to the croaker, *Micropogon undulatus* (Linnaeus), a member of the family Sciaenidae. Data collected in Georgia (Lindner, 1933) show that there *L. xanthurus* and a third sciaenid, *Stellifer lanceolatus* (Holbrook), far outnumber croaker. The importance of knowing what fishes are most abundant is, I assume, as obvious as the uncertainty of the correctness of the estimates of relative abundance given above. They are given because they are thought to be of value at the present stage of our knowledge, and quite likely will be subject to modification when more extensive data are at hand.

It is significant that the first two species listed as most abundant are both plankton feeders. The mullet is a mud and sand-eater, subsisting partly on miscellaneous organic matter, but largely on the diatoms, one or more of which is on every sand grain. It is seen that all three species feed close to the base of the marine food pyramid, the unicellular plants. The mullet is probably closest, since it feeds largely on diatoms, while the anchovy and menhaden feed chiefly on minute crustacea. The small sciaenids are, so far as is known, omnivorous bottom feeders.

Two of the fishes most commonly killed in the freeze of January, 1940, on the Texas Coast, *Bairdiella chrysura* and *Pogonias cromis*, are sciaenids. A

third, the redfish, *Sciaenops ocellatus* (Linnaeus), was not uncommon. The redfish and drum are important foodfish on the Gulf Coast and several million pounds are caught every year. The smaller sciaenids, the croaker, the spot and the yellowtail, are lesser foodfishes and are innumerable. The whitings, *Menticirrhus* are quite common. The least sciaenid, the star-drum, *Stellifer lanceolatus*, is enormously abundant in the open Gulf. Welsh and Breder (1923) state that the banded drum, *Larimus fasciatus* Holbrook, also is one of the most common fish in trawl catches in the Gulf of Mexico. However, I have found this little drum never very numerous and believe that somehow the author's statement was meant to apply to *Stellifer lanceolatus* rather than *Larimus*. The family Sciaenidae has several species, diverse in size and habits in this area. Many of its species are exceptionally abundant. The previous conclusion (Gunter, 1938a) that it is the most successful family in the area should be emphasized and reiterated. The Sciaenidae is by far, and with no close rivals, the dominant family of fishes in the shallow waters of the northern shore of the Gulf of Mexico and, in all likelihood, on the coast of the South Atlantic States as well.

Lastly, attention should be called to the fact that the abundance of fishes may undergo great changes throughout the years. The classic example in North American fisheries is that of the tilefish, *Lophalotilus chamaeleonticeps* Goode and Bean, which was apparently almost exterminated many years ago by some natural catastrophe, but which is slowly becoming worthwhile again as a commercial fish. There is another example, on the Texas Coast. Stevenson (1893), in his report on the coast fisheries of Texas, and Collins and Smith (1893), in their statistical report on the fisheries of the Gulf States, record a catch of several thousand pounds of the hogfish or Capitaine, *Lachnolaimus maximum* (Walbaum) from Galveston Bay and vicinity. In the intervening years this fish has completely disappeared from that bay and the Texas fishery, to such an extent that it is not known to the fishermen of today, and a specimen from Texas inshore waters would be a matter of record. The reasons for this disappearance and the rate at which it took place are unknown. Presumably, the decline was gradual.

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Growth of Tagged Frogs (Rana catesbeiana Shaw and Rana clamitans Daudin) under Natural Conditions

Edward C. Raney and William Marcus Ingram

Little is known concerning the rate of growth of amphibians in nature. Senning (1940) was able to determine the age of *Necturus* by an examination of the lines on the parasphenoid and other bones of the skull. Hamilton (1934) marked toads, *Bufo americanus americanus*, by incising toes and obtained considerable information about their growth rate. Some data on the growth of *Rana pipiens* determined by a study of length-frequency curves based on large numbers of individuals taken at one time have been presented by Force (1933). However, Wright (1931:59) has pointed out that this method needs to be checked by marking and recovering measured individuals. Additional information on age and growth of captive specimens has been reported (see Flower, 1925:272 and Savage, 1935:1074), but obviously such information on growth needs to be checked, if possible, under natural conditions.

A study of the movement and growth of frogs was initiated during the summer of 1939 at the Edmund Niles Huyck Preserve, Rensselaerville, Albany County, New York, when 606 individuals representing five species were tagged by inserting strap tags through the jaw (see Raney, 1940:734, Fig. 1). Returns obtained during the summer of 1940 by Ingram serve as a basis for this brief report on growth. Of 237 specimens of *Rana catesbeiana* tagged in 1939, only 22 were recovered in 1940 and of 324 *Rana clamitans* originally tagged only 4 were recaptured. No tagged specimens of *Rana pipiens pipiens, Rana palustris* or *Bufo americanus americanus* were recovered. The writers wish to express their appreciation at being appointed Research Fellows at the Edmund Niles Huyck Preserve. We acknowledge the assistance and advice rendered by the officers and members of the Biological Advisory Board of the Preserve, especially the late Dr. G. K. Noble, who aided in the field work and gave valuable suggestions.

The Huyck Preserve is an area of approximately 500 acres located in the Helderberg Mountains. Several ponds at an approximate altitude of 1650 feet are present on the Preserve. The two larger of these, Lincoln Pond and Myosotis Pond, are respectively 9 and 90 acres in area. They are connected by a meandering rock bottomed stream, flowing from Lincoln Pond to Myosotis Pond. Most of the frogs were taken in Lincoln Pond, along its outlet, or at the upper end of Myosotis Pond. Several other nearby ponds less than one-tenth of an acre yielded some frogs. An aerial view of the locality showing the salient features of the Preserve is given by Raney (1940:736, Fig. 2).

The ice does not leave these ponds until late April or early May, and in

the autumn most of the frogs appear to have gone into hibernation by the last of September. The approximate limits of the active growing season would appear to be from May 15 to September 15. Most growth probably takes place during June, July and August. However, our data are not adequate to shed much light on this aspect of the problem. The question naturally arises as to the effect of jaw-tags on feeding and subsequent growth of tagged frogs. Observation of tagged frogs in the field showed that a few individuals are aware of the presence of a tag and will often grasp it and pull vigorously. After a year the tissue immediately surrounding the tag was reddish and inflamed in a few. Most frogs do not appear to be affected much, the only effect being a slight proliferation of the tissue about the tag. Juveniles which might have been expected to be handicapped most in their feeding activities by a large tag, in general, showed good growth. After considerable practice the presence and relative abundance of food in the stomach of a living frog was determined by touch, and no difference in the amount of food in the stomachs of tagged and untagged individuals was noted. This method was checked by examining the contents of a number of stomachs. Although data on food are fragmentary, they are included here since no additional studies along this line are contemplated by the writers.

The stomachs of 16 bullfrogs captured between June 16 and August 6 were examined. Five of these 16 were adults. Two of the stomachs of the 5 adults contained frogs; three stomachs contained crayfish; one contained an adult brewer's mole, *Parascalops breweri*, which weighed about one-third as much as the frog; two contained beetles; one stomach held 3 tent caterpillars. The frogs eaten by the two bullfrogs were adult green frogs a little over half as long as the predators. A large female bullfrog was observed in the act of swallowing an adult green frog, 80 mm. long, one very dark night. The green frog was half down when flashed with a spot light. The role of sight in the night feeding of these frogs makes interesting speculation. When present in numbers, crayfish must be a very important item in the food of adult bullfrogs. They could be felt in the stomachs of many of the bullfrogs which were tagged. One large bullfrog was found dead with a 7 inch specimen of bullhead, *Ameiurus n. nebulosus*, in its mouth. The large pectoral spines of the bullhead had penetrated the sides of the head of the frog. Of the stomachs of the 11 juvenile bullfrogs (less than 100 mm. in length) which were examined, eight contained beetle remains (largely Carabidae and Gyrinidae); two contained dragon fly larvae; one contained a species of Diptera, and another contained a hymenopteran. Of the non-insect food one contained a crayfish and another a snail. Of the ten *Rana clamitans* collected all had been feeding on insects, and all but one had remains of beetles of various species in the stomach.

The body length was measured from the tip of the snout to the posterior-most point of the pelvic girdle when the frog was placed in a somewhat depressed sitting position and the vertebral column was straight. It was found that a specimen could be measured repeatedly with an error of one millimeter or less.

Growth of Rana catesbeiana

The data on the growth of bullfrogs are summarized in Table 1. One male, No. 506, was measured four times (twice each summer). Four others were remeasured once during the same summer in which they were tagged. Some 22 specimens were recaptured at least once approximately a year after being first measured.

There is considerable variation in the rate of growth. As might be expected the juvenile bullfrogs grow more rapidly than the adults. A juvenile bullfrog, No. 309, was 67 mm. when measured July 11, 1939, and had gained 25 mm. when measured June 17, 1940. By July 17, 1940, it was 110 mm. long, a gain of 18 mm. in a month. This specimen had grown at a much greater rate during the last month than during the previous period of about a year. Two other immature frogs, Nos. 606 and 641, grew considerably during the period of a year, each having gained 48 mm. in length. Some juveniles grew much more slowly. For example, No. 919, grew only 3 mm. during a period of a month and one-half. Another juvenile, No. 630, was only 11 mm. longer, a year after the first measurement was made. For a period of little more than a year the mean growth increment in 11 juveniles was 32 mm. (11 to 48 mm.); in 6 females 18.5 mm. (14 to 26 mm.); in 5 males 13.6 mm. (5 to 19 mm.). This apparent difference in rate of growth of males and females is not statistically significant. Females probably attain a slightly greater maximum size. Two females, Nos. 273 and 357, both 130 mm. long when first measured, added 20 and 19 mm. respectively in a period of slightly over a year to reach a length of 150 and 149 mm. which is very close to the maximum size attained at this locality.

Our field observations, a study of the data on growth presented in Table 1, and certain characteristics of the bullfrog population as represented by a curve of the length-frequency distribution permit some tentative conclusions regarding the life cycle at this locality. It may be assumed that the bullfrogs at Rensselaerville spend two and occasionally three winters in the tadpole stage (See Wright, 1914:85). Transformation occurred from July 16 to August 28, 1940, at an average length of 45 mm. A considerable range in size of newly transformed individuals was noted. Some specimens attain a size of 53 mm., while others only 35 mm. long were taken as late as August 28 with only a minute tail stub remaining. The smallest transformed specimen seen was one measuring 27 mm. taken in a small pond on July 18. In the Ithaca region Wright (1914:85) found the transformation period to extend generally from July 15 to the last of August. He found the size at transformation to vary from 43 to 59 mm.

The data indicate that an average sized bullfrog which transformed during the last two weeks in July would reach maturity in late August of the following year at a size ranging from 85 to 105 mm. It would be capable of spawning the following July, two years from the time of transformation. Two individuals, Nos. 311 and 813, are cases in point. In 1939 they were 72 and 71 mm. in length; both probably had transformed during the previous summer.

TABLE 1.—Growth Data on *Rana catesbeiana*, Rensselaerville, N. Y.

Recaptured during the same summer as tagged							
Tag No.	Sex	Date Measured	Body length in mm.	Date remeasured	Body length in mm.	Elapsed period in days	Increase in body length
506	♂	VI:24:1939	120	VII:14:1939	126	20	6
506	♂	VI:16:1940	139	VII:18:1940	139	32	0
514	♂	VI:24:1939	120	VII:17:1939	128	23	8
935	♂	VI:24:1939	116	VIII:28:1939	126	65	10
309	im.	VI:17:1940	92	VII:17:1940	110	30	18
919	im.	VII: 1:1939	85	VIII:11:1939	88	41	3
Recaptured during the following summer							
Tag No.	Sex	Date Measured 1939	Body length in mm.	Date remeasured 1940	Body length in mm.		Increase in body length in mm.
107	♂	VI:19	120	VI:16	125		5
164	♂	VI:22	113	VII:17	128		15
430	♂	VII:11	120	VII:17	136		16
437	♂	VII:11	119	VII:17	132		13
506	♂	VI:24	120	VI:16	139		19
506	♂	VI:24	120	VII:18	139		19
273	♀	VII:7	130	VII:19	150		20
357	♀	VII:10	130	VII:20	149		19
443	♀	VII:11	95	VII:17	121		26
471	♀	VII:11	123	VII:24	138		15
509	♀	VII:16	122	VII:18	136		14
513	♀	VII:17	108	VII:17	125		17
188	im.	VI:24	82	VII:16	115		32
304	im.	VII:9	67	VII:17	94		27
309	im.	VII:9	67	VI:17	92		25
309	im.	VII:9	67	VII:17	110		43
311	im.	VII:9	72	VII:28	110		38
606	im.	VII:11	70	VII:18	118		48
619	im.	VII:14	67	VII:21	101		34
622	im.	VII:14	71	VII:21	94		23
630	im.	VII:14	73	VII:17	84		11
641	im.	VII:14	69	VII:16	117		48
813	im.	VIII:11	71	VII:28	109		38
943	im.	VIII:28	90	VII:20	104		14

By July 28, 1940, they had attained a length of 110 and 109 mm., and were easily identified as adult females. Some slower growing juveniles like No. 630 would probably not reach maturity until a period of three years had elapsed, and would not spawn until four years after transformation.

After attaining maturity the faster growing individuals among the females reach a point very close to their maximum length (about 155 mm.) in two years. The female showing the slowest growth in Table 1 would likely reach this stage in 3 or 4 years. It should be noted that the rate of growth does not decrease greatly in females which are near the maximum. For instance, No. 273 grew from 130 to 150 (close to maximum) in one year. The growth incre-

ments in very old captive specimens must be quite small. Flower (1925:272) mentions a bullfrog which reached a known age of nearly 16 years in the London Zoological Garden. The maximum age attained in nature is not known.

Some males would reach a size very close to their maximum 2 to 3 years after attaining maturity. The slower growing individuals might require 4 or even 5 years. One cessation of growth occurred which is difficult to explain. The case in point is a male, No. 506, who was captured and measured four times. He measured 120 mm. when first captured on June 24, 1939, and had gained 6 mm. by July 14. The next year on June 16 he was 139 mm. long, a gain of 13 mm. from the previous date and a gain of 19 mm. in a little less than a year. When next measured on July 18, 1940, he was still 139 mm., no gain having been made during the elapsed month. It may be that this male had nearly reached his maximum length or possibly he had not increased due to spawning activities.

Growth of Rana clamitans

The data on greenfrogs are presented in Table 2. Only four of the 324 tagged greenfrogs were recovered during the following summer. One other record is available from Ithaca, New York. Little may be gleaned from so few returns especially since no immature specimens were recovered. The gains in four males ranged from 3 to 8 mm. with an average of 5.5 mm. in approximately a year. Two other adults of both sexes had increased but 1 mm. over periods of 2 and 5 months. It is probable that the presence of the tag interferes more with this more active species than with the bullfrogs. However, more investigation needs to be done before much may be said.

TABLE 2.—Growth Data on *Rana clamitans*, Rensselaerville,* N. Y.

Recaptured during the same summer as tagged							
Tag No.	Sex	Date Measured	Body length in mm.	Date remeasured	Body length in mm.	Elapsed period in days	Increase in body length
1292	♂	V: 3:1940	92	IX:16:1940	93	136	1
950	♀	VI:30:1939	90	VIII:28:1939	91	59	1

Recaptured during the following summer						
Tag No.	Sex	Date Measured 1939	Body length in mm.	Date remeasured 1940	Body length in mm.	Increase in body length in mm.
427	♂	VII:11	79	VII:24	82	3
667	♂	VII:17	80	VII:17	88	8
838	♂	VIII:21	88	VII:18	95	7
954	♂	VIII:28	77	VI:16	81	4

* One specimen, No. 1292, was tagged and recaptured at the Cornell Experimental Hatchery, Ithaca, New York.

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A History of Arkansas Ornithology

William H. Deaderick

In 1673 Jacques Marquette and Louis Joliet (1) made a voyage down the Mississippi River as far as the mouth of the Arkansas and their journal gives the first description of the river and the adjacent country. Near Mitchigamea, supposed to be the site of the present town of Helena, they "saw quails and shot a parrot which had half of its head red, the neck yellow, and the rest of the body green."

When LaSalle was murdered, his lieutenant, Henri Joutel, organized the loyal followers and continued to the fort established on the banks of the Arkansas River by De Tonti's men the preceding year, later the site of Arkansas Post, which they reached May 24, 1687. In his trustworthy account of the expedition Joutel (2), writing of this locality, states that "the plains lying on one side of it are stored with beeves, wild goats, deer, turkeys, bustards, swans, teal and other game."

The French regent, the Duke of Orleans, ordered Bernard de La Harpe (3) to explore the Arkansas River and establish a regular garrison at Arkansas Post, prior to which time the place had been only a trading and military post among the Indians. During 1721 and 1722 La Harpe traveled the Arkansas River as far up as Fort Gibson, now in Oklahoma. He found turkeys plentiful, some of which he killed.

During his first visit to America Jean Bernard Bossu (4), a captain in the French Marines, traveled along the Arkansas River in what is now the state of Arkansas. Under the date of Nov. 6, 1751, he writes "game of all kinds is plentiful there . . . turkeys, grous, pheasants, partridges, quails, turtles, wood pigeons, swans, geese, bustards, ducks of all kinds, teals, divers, snipes, water hens, golden plovers, stares, thrushes and other birds which are not known in Europe." The "turtle" is the mourning dove and the "stare," the meadowlark.

In 1718 Antoine Simon Le Page Du Pratz (5) was sent to Louisiana with eight hundred emigrants, mostly Alsatians, in promotion of John Law's "Mississippi Bubble." Law had received from the regent of France a grant of land twelve leagues square, a few miles up the Arkansas River from the post established by De Tonti, later Arkansas Post. Du Pratz located first in Louisiana on Bayou St. John, but dampness and flood danger caused him to move near Fort Rosalie among the Natchez. Later he moved to the Arkansas region. Of this section he wrote: "In all the groves and little forests I have mentioned and which lie to the north of the river of the Arkansas, pheasants, partridges, snipes and woodcocks are in such great numbers that those who are most fond of this game might easily satisfy their longing as also every other species of game. Small birds are still vastly more numerous." In his history of Louisiana,

first published in 1758, he gives an annotated list of fifty-nine species of birds, some of which were probably observed in what is now Arkansas.

President Jefferson, in 1804, authorized William Dunbar of Natchez, Mississippi, to explore the Ouachita River and make a report on the hot springs of Arkansas. Dunbar was accompanied by Dr. George Hunter, young Mr. Hunter and twelve soldiers headed by a sergeant. Leaving St. Catherine Landing on the Mississippi River the party headed for the Ouachita in Arkansas. While in this state from Nov. 15, 1804, to Jan. 14, 1805, they saw swans, ducks, geese, and turkeys. A few days before reaching the hot springs Dunbar (6) wrote: "The effect [of the scenery] was greatly heightened by a flock of swans which had taken their stations under the walls which rose out of the water; as we approached, the birds floated about majestically upon the glassy surface and in tremulous melancholy accents seemed to consult each other upon measures of safety; the ensemble produced truly a sublime picture."

Henry Rowe Schoolcraft (7), an American ethnologist, made a trip down the Black and White Rivers in the winter of 1818-1819. The purpose of the journey was to study the mineralogy and geology of the section. He mentions turkeys, ducks, brant, geese, an eagle, a hawk, a heron and a prairie hen.

Thomas Nuttall (8) in 1819 made a trip down the Mississippi River and up the Arkansas into what is now Oklahoma. It is extremely regrettable that the naturalist who later became the author of the first "hand-book" on ornithology and whose name was borne by the first ornithological association in America, the Nuttall Ornithological Club, was so chary with ornithological references in his account of this journey. He was at this time, however, primarily interested in botany, and the work abounds in interesting botanical information of the territory through which he passed. He mentions mammals, reptiles and even fossils and records numerous geological observations. He mentions "flocks of screaming parrots" seen Jan. 7, 1819, near the mouth of the St. Francis River and the shooting of wild geese near Arkansas Post with Dr. M'Kay later in the same month. He refers to the whip-poor-will near Dardanelle, "the melody of innumerable birds" at Mulberry Creek in Franklin County and the vociferations of the two species of whip-poor-will at Cedar Prairie. On Jan. 22, 1819, from Arkansas Post he writes that birds were singing from every bush particularly the redbird and the bluebird. Dec. 10, 1819, he says that the bald eagles are already nesting near the Second Pine Bluffs. These constitute about all of his allusions to birds.

Timothy Flint (9), Congregational pastor and missionary, who later occasionally delivered lectures on natural history, visited the territory in 1819. Referring to the lower Arkansas River he made his only contribution to ornithology in the statement: "I traveled forty miles along this river swamp and a considerable part of the way in the edge of it. . . . Like the ancient Avernus I do not remember to have seen a single bird in the whole distance except the blue jay."

Stephen Harriman Long, an army engineer assigned to a survey of the Mississippi River and its tributaries, made an expedition to the territory in 1820. The account of this journey was written by Edwin James (10). The

naturalist on this expedition was Thomas Say. After a description of various parts of Arkansas, James says: "Of the animals found in the several sections of country above described there are a great variety in almost every department of zoology. But as most of them are common in other parts of the United States they need not to be enumerated here." Unfortunately Say's manuscript "Zoological Descriptions and Remarks" was lost by the desertion of three soldiers of Capt. Bell's party. The *Arkansas Gazette* of Oct. 24, 1820, contains an advertisement offering a reward of two hundred dollars for the capture of Mordica Nowland, Peter Bernard, and Charles Myers, robbers and deserters from a detachment of Major Long's expedition on the night of Aug. 30, 1820, taking with them, among other things, one manuscript on topography, a journal, a manuscript on zoology, one on Indian manners and customs, and two containing vocabularies of Indian languages. The advertisement is signed by William Bradford, Major Commandant, Fort Smith.

John James Audubon left Cincinnati Oct. 12, 1820, in a flat boat bound for New Orleans where he arrived Jan. 7, 1821. Of this time he was in Arkansas or waters contiguous from Nov. 26 to Dec. 20, 1820, inclusive. The rate of travel was slow, there were numerous tie-ups, and for some whole days, on account of unfavorable wind, the craft remained moored. He was enabled to follow afoot, to cut across bends and catch the boat downstream or even to spend whole days in the woods.

When he left Cincinnati he took with him letters of introduction all of which were addressed to residents of Arkansas Post, the capital of Arkansas Territory, excepting a general letter of introduction given him by Henry Clay. The other letters were from General, later President, W. H. Harrison, General Lytle, Dr. Elijah Slack, and Dr. Daniel Drake, and were addressed to Territorial Governor James Miller, Indian Agent Col. David Brearly and to two missionaries. The concentration of attention on Arkansas Post was due to Audubon's desire to be appointed as naturalist on any expedition Governor Miller might contemplate for the exploration of the Arkansas River.

His account of the visit to the Post is one of the most interesting portions of the journal (11) but the trip did not accomplishe the desired result as Governor Miller and the others addressed in the letters were absent. In this journal he records fifty Arkansas species of birds which are identifiable and several others which cannot be placed definitely.

From the fact that there are at least four birds credited to Arkansas and mentioned by Audubon in his Ornithological Biography (12) that are not recorded in his journal of 1820-1821, and that one of these, the alder flycatcher, a new species, was collected at the "Fort of Arkansas, Apr. 17, 1822," it follows that he made another trip into the state.

Arthur (13) has reconstructed this visit. Hearing no word from the letters he left at Arkansas Post, Dec. 11, 1820, Audubon took advantage, while at Natchez, in mid-April 1822, of an opportunity to return by steamboat to the Post. He was again disappointed as no territorial expedition for a survey of the western limits of the United States was being planned. It was probably during this visit that the specimens mentioned were collected.

Zadok Cramer, author of *The Navigator*, a guide for the navigation of the Ohio and Mississippi Rivers, in the eleventh edition published at Pittsburgh in 1821, writes of what is now known at Porter's Lake, just north of Helena, as follows: "One mile and a half back of the settlement is a lake two miles wide and two miles long, a place of great resort for swans, geese, ducks, &c."

In 1832 Charles Joseph Latrobe (13), a British traveler, politician and naturalist, accompanied by Washington Irving and Count Albert Pourtales made a trip from the east through Cincinnati and Independence, Mo., to Fort Gibson, Okla. From here Latrobe and Pourtales took a canoe trip on the Arkansas River as far as Little Rock where they embarked upon a steamer to Montgomery Point at the mouth of White River. He relates that "the bright shoals were at this season [early December] covered with long lines of ducks, geese and brants. . . . Swans were occasionally met with and such immense flocks of pigeons as I dare not describe lest I should be accused of showing the inventive powers and disposition of many of my class."

George William Featherstonaugh (14), an English traveler and geologist, passed through Arkansas in 1834 on his excursion from Washington, D. C., to the Mexican border. In northeast Arkansas he "saw the first tvory-billed woodpeckers (Picus principalis), a beautiful bird not found farther north than this part of the country." Near Helena flocks of pigeons "many miles long came across the country, one flight succeeding another, obscuring the daylight, and in their swift motion creating a wind and producing a rushing and startling sound that cataracts of the first class might be proud of."

Much of the time between 1839 and 1842 Frederick Gerstaecker (15), a German traveler and hunter, spent in Arkansas. He reported that "flocks of wild turkeys filled the forests as thick as partridges in Germany." He saw ducks and "innumerable wild geese." He tells of shooting at an eagle which he concluded he missed as it floated motionless in the air, then, flapping its wings, it mounted higher and higher until it could hardly be distinguished, when it turned in the air and fell dead to the ground.

In 1847 Samuel Cabot (16) reported the donation by Major Townsend of two specimens of birds from Arkansas, the American avocet and the yellow-headed blackbird. These are the only records of either species from this state. The exact locality of the collection is not stated.

Baird, Cassin and Lawrence (17), in the exploration for a railroad route from the Mississippi River to the Pacific, record a paroquet taken near Fort Smith in 1858, and Kennerly (18), in a survey near the thirty-fifth parallel, reports a paroquet and a yellow-crowned night heron near the same town in 1859.

H. S. Reynolds (19) contributed the first local list of birds in 1877. It was based on one season's observation in White County and contained 29 species. The cardinal is omitted from the list and the summer tanager included which he says "enlivened the landscape all winter."

Prof. F. L. Harvey has the unique distinction of being the only person to receive the Ph. D. degree from the University of Arkansas where he was a

member of the faculty from 1875 to 1887. He contributed brief articles on the nighthawk (20) and the woodcock (21) from Fayetteville.

When Wells Woodbridge Cooke (22) undertook the study of the migration of birds in the Mississippi valley in 1882 only 13 ornithologists were found in the entire area to cooperate by forwarding observations. Of this number Harvey was the only reporter for Arkansas. When the same work was undertaken for the spring of 1883, 26 furnished reports, of whom Harvey was again the only reporter for the state. William A. Monroe, of Newport, reported for 1884 and 1885; C. E. Pleas of Clinton for 1889 and 1890; Louise M. Stephenson, Helena, 1894-1916; G. Dallas Hanna, Van Buren, 1910-1911; and Walter G. Savage, of Delight, from 1910 to 1914.

Oliver Perry Hay (23), the vertebrate paleontologist who assisted in geological surveys of Arkansas, published an annotated list of 29 species observed in the summer of 1881 near Hopefield in Crittenden County, opposite Memphis.

C. E. Pleas of Clinton, who cooperated with Cooke in his migration studies, and his wife Mrs. Lillie Pleas, contributed 17 articles to ornithological literature from 1888 to 1897.

Arkansas' first resident ornithologist who outranked all who preceded her and most of those who have followed was Louise McGowan Stephenson of Helena. Mrs. Stephenson acted as reporter to the Biological Survey from 1894 to 1916. In a personal communication from Mr. Arthur H. Howell he states that her migration schedules were very accurate. Her first report indicates that she began to record observations on birds in 1886 at which time the only help she had in identification of the species was what she obtained from Webster's Dictionary. About 1890 she obtained a copy of Florence Merriam's "Fifty Common Birds" and Studer's "Birds of North America." Mr. Howell further states that her records are quoted extensively in his "Birds of Arkansas," adding materially to the value of the work.

For a number of years Mrs. Stephenson contributed to the weekly *Helena World* of which she was "Bird Editor." A review of only three years of the *World* shows that during this time she published 44 articles on various phases of bird life.

She was a pioneer in the movement against the commerce in bird feathers for millinery purposes, her first article on this subject appearing Jan. 26, 1898.

Mrs. Stephenson was solely responsible for the passage of the Act of Mar. 15, 1897, Arkansas' first comprehensive law protecting non-game birds. This act was one of the first of its kind in any of the southern states.

She started a campaign toward the establishment of bird day in the schools by an article published Nov. 11, 1896, closely followed by others. Early in 1897 the State Superintendent of Public Instruction issued directions for observance of a bird day in the schools, giving Mrs. Stephenson full credit for the measure. Mrs. Stephenson was born in Orangeville, Mich., in 1848. She married Judge M. L. Stephenson of Helena, Ark., Nov. 27, 1872, and lived

there until her death on Aug. 1, 1916. Further biographical data are to be found in her obituary in *The Auk*, vol. 57, p. 446.

A very interesting figure in Arkansas ornithology was Albert Lano of Fayetteville. Born at Chaska, Minnesota, Jan. 2, 1860, his early life was spent on a farm. Later he studied pharmacy in Minneapolis and in Milwaukee. He was in the drug business in several Minnesota towns, including Madison. After nine years in Aitkin he sold out in the spring of 1905, as close confinement and long hours were telling on his health, and moved to the Lake Minnetonka district to go into the fruit and poultry business. His sight began to fail but he continued his bird studies. In a personal communication Dr. Thomas S. Roberts says: "Once I went out to his home at Excelsior, near Minneapolis, to look over his collection which he wanted to sell to the university. He was a friendly, agreeable man and the visit was a pleasant one. We strolled about in his yard, listening to the birds in the trees. His vision was dim but he was not entirely blind. With the aid of glasses he got about fairly well but could not see to write or read. He had at that time about 1500 bird skins of which he had collected about one-half in Minnesota and had gotten the others by exchange. He made good specimens and recorded the measurements, weight and stomach contents (of the larger birds), so that his collection was especially valuable on this account. Just as he was leaving Minneapolis this collection was sold to the University of Minnesota for $1500."

Lano moved to Fayetteville in September 1912. After becoming totally blind he was able to identify birds by their notes. The loss of sight was compensated by an uncanny acuteness of hearing, and his ability to recognize the songs and other notes of birds was remarkable. Nor did he give up the making of bird skins. Some of his specimens prepared after becoming totally blind are now at the University of Arkansas and are among the best in the collection.

He was beloved by the school boys and girls of Fayetteville and was known as the "Bird Man" for his lectures to them on bird life and his field trips made with them. He was an associate of the American Ornithologists Union from 1917.

Roberts, in his "Birds of Minnesota," makes frequent references to Lano's specimens especially in the descriptions in the keys. Baerg, in his "Birds of Arkansas," states that Lano helped in the earlier studies that form the foundation of his work.

Albert Lano died at Fayetteville, July 3, 1928.

The study of the evolution of a state bird list is an interesting one. The following is a record of the development and growth of that of Arkansas. The dates correspond to references in 'An Annotated Bibliography of Arkansas Ornithology," Amer. Midl. Nat. vol. 24, pp. 490-496, 1940.

Marquette. 1673.
Bobwhite
Paroquet
Joutel. 1687.
Eastern Turkey
Canada Goose
Trumpeter Swan
Bossu. 1751.
Ruffed Grouse
Mourning Dove
Meadowlark
Golden Plover

Du Pratz. 1758.
Woodcock
Nuttall 1819.
Whip-poor-will
Cardinal
Bluebird
Flint. 1819.
Blue Jay
Audubon. 1820-1821.
Mississippi Kite
Slate-colored Junco
Bald Eagle
Black Vulture
Turkey Vulture
Ivory-billed Woodpecker
Great Blue Heron
Carolina Wren
Purple Finch
Goldfinch
Green-winged Teal
Sandhill Crane
Swamp Sparrow
Pintail
Cedar Waxwing
Crow
Broad-winged Hawk
Red-shouldered Hawk
Towhee
American Merganser
Rough-legged Hawk
Flicker
Sparrow Hawk
Mallard
American Pipit
Killdeer
Kingfisher
Myrtle Warbler
Winter Wren
Bronzed Grackle
Bonaparte Gull
Eastern Redwing
Golden-crowned Kinglet
Fish Crow
Marsh Hawk
Phoebe
White Pelican
Great Horned Owl
Oven Bird
Brown Thrasher
Double-crested Cormorant
Audubon. 1831-1839.
Alder Flycatcher
Snowy Owl
Long-billed Curlew
Prairie Warbler
Latrobe. 1832.
Passenger Pigeon
Cabot. 1847.
Avocet
Yellow-headed Blackbird
Kennerly. 1859.
Yellow-crowned Night Heron.
Baird, Brewer and Ridgway. 1874.
Yellow-breasted Chat
American Redstart
Reynolds. 1877.
Eastern Robin
Hermit Thrush
Mockingbird
Tufted Titmouse
Carolina Chickadee
White-breasted Nuthatch
House Wren
Pileated Woodpecker
Downy Woodpecker
Yellow-bellied Sapsucker
Red-bellied Woodpecker
Barn Owl
Barred Owl
Screech Owl
Coues. 1879.
Lapland Longspur
Sprague's Pipit
Harvey. 1880.
Eastern Nighthawk
Hay. 1882.
Wood Thrush
Catbird
Black and White Warbler
Prothonotary Warbler
Parula Warbler
Maryland Yellow-throat
Red-eyed Vireo
White-eyed Vireo
Bank Swallow
Summer Tanager
Indigo Bunting
Baltimore Oriole
Kingbird
Crested Flycatcher
Wood Pewee
Red-headed Woodpecker
Wier. 1882c.
Whooping Crane
Cooke. 1883.
Green Heron
Wood Duck
Cooke. 1888.
Water Turkey
Red-cockaded Woodpecker
English Sparrow
Chuck-will's-widow
Smith's Longspur
Purple Martin
Brown-headed Nuthatch
Ragsdale. 1889.
Loggerhead Shrike.
Blue-gray Gnatcher
Pleas, Mrs. Lillie. 1891e.
Blue-gray Gnatcatcher

Pleas, C. E. 1892b.
Ruby-throated Hummingbird
Bendire. 1892.
Red-tailed Hawk
Swainson's Hawk
Duck Hawk
Osprey
Mitchell. 1894.
Clark's Nutcracker
Bendire. 1895.
Scissor-tailed Flycatcher
Pleas, C. E. 1896.
Bewick's Wren
Widman. 1896.
Bachman's Warbler
Pleas, C. E. 1897.
Carolina Rail
Hollister. 1902.
Baldpate
Hutchin's Goose
Virginia Rail
Wilson's Snipe
Prairie Chicken
Long-eared Owl
Harlan's Hawk
Short-eared Owl
Rusty Blackbird
Brewer's Blackbird
White-crowned Sparrow
Field Sparrow
Song Sparrow
Brewster. 1902.
Red-legged Black Duck
Cooke. 1903-1906.
Hooded Warbler
Yellow Warbler
Kentucky Warbler
Cooke. 1904.
Magnolia Warbler
Cerulean Warbler
Sycamore Warbler
Wilson's Warbler
Cooke. 1907.
Willow Thrush
Cooke. 1907-1909.
Acadian Flycatcher
Cooke. 1909.
Warbling Vireo
Yellow-throated Vireo
Cooke. 1909-1911.
Henslow's Sparrow
Chipping Sparrow
Painted Bunting.

Thus was teh avifaunal list evolved and recorded from 1673 to 1911, these 148 species and subspecies constituting the uncompiled state list, when in the latter year Arthur Holmes Howell's "Birds of Arkansas" appeared as Bulletin no. 38 of the Biological Survey. The author made a collecting trip to the state, covering about two and a half months and a large portion of the state. To the information gained from the literature and from his collecting trip were added the reports of the six Arkansas observers who sent records to the Biological Survey and the data gathered by other members of the Survey who had made trips to the state. The latter were Edward A. Preble, B. H. Dutcher, C. E. Brewster, and W. L. McAtee. Howell's monograph lists 255 species and subspecies.

The Arkansas Bureau of Mines, Manufacturers and Agriculture published in 1924 a list of the permanent and summer residents of the state. This list was prepared by H. E. Wheeler and contains 150 species and subspecies.

The latest and most authoritative Arkansas list is that of Dr. William J. Baerg of the University of Arkansas, whose "Birds of Arkansas" appeared in 1931. This carefully prepared work lists 297 species and subspecies.

The compiler of a state list has a much easier task if there is a well-annotated list for every county in the state. In Arkansas about a dozen, only, of the 75 counties have bird lists, many of these incomplete. The following table enumerates the local lists of the state:

Reynolds, 1877, 29 species, White County.
Hay, 1882, 29 species, Crittenden County.
Hollister, 1902, 51 species, Grand and White River Prairies.
Cavaness, 1911, 19 species, Drew County.

Smith, 1915, 143 species, Washington County.
Hunt, 1921a, 98 species, Drew County.
Pindar, 114 species, Poinsett and Phillips Counties.
Baerg, 1927, 48 species, Logan County.
Baerg, 1930b, 81 species, Washington County.
Hunt, 1931, 73 species, Pulaski and parts of adjoining counties.
Black, 1935a, 175 species, Washington County.
Deaderick, 1939, 208 species, Garland County.

There is at present, so far as known, no ornithological organization in Arkansas. Bird clubs organized at Little Rock, Fort Smith and possibly in other localities have become defunct. The Audubon Society, in its annual summary of Junior Audubon Clubs and members enrolled under the Children's Educational Fund, lists 19 clubs and 825 members as of June 1, 1930, 13 clubs and 509 members June 1, 1931, and 11 clubs and 505 members June 1, 1932.

The first native of the state to join the American Ornithologists Union as associate was Carrington C. Bacon, of Imboden, in 1890. Mrs. Louise McGowan Stephenson of Helena affiliated in 1894, Bertie Lawrence Combs, Hot Springs, in 1895, Mrs. Amelia A. Hollenberg, Little Rock, in 1898, Philo W. Smith, Jr., Eureka Springs, 1903, and Clarence H. Luther, Fayetteville, in 1910.

The history of bird legislation in Arkansas may be divided into four definite periods: 1. From 1875 to 1884, during which the only legislation of this kind was the Act of Mar. 6, 1875, which provided that non-resident market hunters and trappers pay an annual license fee of ten dollars. 2. From 1885 to 1896, when game birds, only, received legislative consideration (excepting the law protecting nests and eggs.) 3. From 1897 to 1916, when non-game birds were protected; and 4. From 1917 to the present time, the period of operation of the State Game and Fish Commission.

1. The Act of 1875 afforded, at least at first, greater protection to the native pot hunter than to the birds as it excluded non-resident professionals and gave the resident free rein. Eventually the act was probably responsible for an influx of outsiders who took up residence in the state.

2. In 1885 the Act of Feb. 23 prescribed closed seasons for wild turkey, pinnated grouse and quail, and prohibited the use of nets, traps or pits to take these birds, to purchase or sell them, or to ship them during the closed season. This act further made it unlawful to destroy, disturb or rob the nests of any wild birds whatsoever except those of crows, blackbirds or birds of prey. It seems rather incongruous that nests and eggs should be protected years before it was considered necessary to extend this protection to the birds.

The Act of Apr. 14, 1893, declared all game found in the limits of the state to be the property of the state and made it unlawful to ship game to points beyond the limits of the state. In 1893 it was made unlawful to take pinnated grouse for a term of five years.

3. Until Mar. 15, 1897, only three birds were considered of sufficient value to be protected, the wild turkey, pinnated grouse, and quail. On that date the legislature passed a statute making it unlawful to kill, wound or injure any wild bird other than the game birds, or to sell either dead or alive any of such

birds or any of their eggs, or to transport any such birds or eggs. English sparrows, crows, blackbirds and birds of prey were exempt from the provisions of this act, nor did it prohibit any person from killing any such birds on his own premises when in the act of destroying fruit or other crops.

The passage of the act was due solely to the efforts of Mrs. Louise McGowan Stephenson of Helena.

The Act of Mar. 14, 1903, made it unlawful to purchase or have in possession for barter, exchange or sale wild turkey, pinnated grouse, quail or other kind of game, wildfowl, or birds whatsoever.

On Apr. 24, 1903, the legislature declared "it shall be unlawful for any person who is a non-resident of the state of Arkansas to shoot, hunt, fish or trap at any season of the year." This was carried to the supreme court in 1904, in the case of State vs. Mallory, and was held unconstitutional.

4. The State Game and Fish Commission was created by the legislative act Feb. 23, 1917. This commission consisted of five members appointed by the governor. Each member must be a member of the state and interested in and devoted to the preservation of wild life, and serve without pay except the secretary who received a salary. Their duties were to superintend and direct laws, adopt ways and means to conserve, and establish rules governing the propagation, sale and export of wild life. They had charge of the issue of licenses required by the act, and were empowered to employ game wardens not to exceed eight in number.

The act fixed closed seasons for turkeys, ducks, geese, snipes, gallinules, coots, woodcocks, pheasants, grouse, prairie chickens, quail, mourning doves, black-bellied and golden plovers, and greater and lesser yellow-legs and prescribed bag limits.

The Act of Mar. 18, 1927, provided for permits to collect, possess, buy and sell migratory and other game birds and animals for scientific and propagative purposes.

On Mar. 3, 1931, an act was passed empowering the commission to promulgate and have published a regulation making the time and manner of taking migratory birds in this state conform to regulations promulgated and adopted by the United States Department of Agriculture.

The State Game and Fish Commission was reorganized by an Act of Jan. 29, 1937. The new body consists of one member from each of the seven congressional districts and the professor of zoology in the University of Arkansas. This act reduced bag limits, changed dates of open seasons and enabled the apopintment by the commission of any number of deputy game wardens.

There are five classes of patrolled areas in the state where hunting is either wholly prohibited or controlled, the combined acreage of which is about two and a half millions.

The State Game and Fish Commission supervises twelve state game refuges, total acreage 229,250, where no hunting of any kind is permitted.

The State Park Commission controls the ten state parks with an aggregate acreage of 17,952 where birds of all kinds are protected and cats are destroyed.

There are two national forests, the Ouachita and the Ozark, totaling about 2,200,000 acres. They contain 30,000 acres of game refuges and a game management area of 78,000 acres. Hunting is permitted under state and federal laws in the forests but not in the refuges or game management area.

The Biological Survey administers the Big Lake Migratory Bird refuge, a 9,542-acre tract, and the White River Migratory Waterfowl Refuge, covering 101,857 acres. Ecological studies are conducted at the latter refuge.

Hot Springs National Park is superintended by the U. S. Department of the Interior. The park covers 1,015 acres and is patrolled by five rangers.

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Annotated List of Mammals of the Tularosa Basin, New Mexico

W. Frank Blair

Introduction

Two trips were made to the Tularosa basin of southern New Mexico to study the Chihuahua deer-mouse. From October 5 to December 10, 1938, extensive trapping was done to collect large breeding stocks of deer-mice. From February 24 to May 24, 1940, certain tracts in the mesquite near Alamogordo were trapped intensively in a study of the home ranges of this species, and incidental trapping was done in some other parts of the basin. In the course of the two trips, various distributional records and ecological notes were obtained which supplement previous studies of the mammals of all or part of the region by Dice (1930), Bradt (1932), and Benson (1933). The present report lists the species and races of mammals recorded from that part of the Tularosa basin extending from the vicinity of Carrizozo in the north, south to Escondida. It also contains all of the original information about their life histories and ecology available to me except the home range and population data from the 1940 trip. These will be published at a later date, as will the data on the breeding stocks.

The first trip was supported in part by a grant to the Laboratory of Vertebrate Genetics from the Carnegie Institution of Washington. The second was supported in part by a grant from the Horace H. Rackham School of Graduate Studies of the University of Michigan. I was accompanied on both trips by my wife, Fern Ann Blair, who acted as field assistant. I am indebted to Tom Charles, Johnwill Faris, and George Sholly of the National Park Service for many courtesies rendered during our stay in the region and during our work on the White Sands National Monument. I wish to thank Sam McNatt, Charles Bonnell, and R. D. Champion for permission to do much of our field work on their respective ranches. Most of the specimens of mammals that were prepared in the field are in the collection of the University of Michigan Museum of Zoology. Most of the mammals that were sent in alive are in the collection of the Laboratory of Vertebrate Genetics.

Ecological Associations[1]

Descriptions of the environmental conditions in the Tularosa basin have been given by Ruthven (1907), Meinzer and Hare (1915), Dice (1930), and Benson (1933). Consequently, only a brief description is necessary here. The Tularosa basin, in the vicinity of Alamogordo, is approximately 40 miles wide, but it narrows northward. The basin is a relatively level plain that slopes gently toward the center. It is bounded on the east by the Sacramento Mountains and on the west by the San Andreas. The elevation over most of the

[1] An ecological association, as here defined, includes all of the plants and animals occurring together in a relatively stable environment.

area under consideration is around 4000 feet. Three distinct belts of vegetation characterize the basin. Nearest the foothills there is a belt of creosote bush *(Larrea tridentata)*, often several miles wide. Toward the middle of the basin the creosote bush often is paralleled by a belt of mesquite *(Prosopis glandulosa)*. Then, the interior of the basin is largely occupied by the salt-bush *(Atriplex canescens)*. This zonation is locally interrupted due to various edaphic conditions. Near the middle of the basin west of Alamogordo, the White Sands, of nearly pure gypsum, occupy about 270 square miles. Southeast of the White Sands, an extensive area of red sand dunes, with mesquite as the principal plant, extends nearly across the basin. North of the White Sands, there is an extensive area of quartz sand, which extends northward nearly to the Malpais. The Malpais is a long, narrow bed of dark lava rock that extends approximately 40 miles down the basin from a point northwest of Carrizozo. Both the Malpais and the White Sands have vegetation types that differ from those of the surrounding desert plain. The White Sands have one pale colored endemic race of mammal, the gypsum pocket-mouse *(Perognathus apache gypsi)*. Five dark colored races of mammals are endemic to the Malpais.

Eight important ecological associations are recognized in the Tularosa basin. Of these, the creosote bush, mesquite, atriplex, sumac—yucca, and Malpais lava associations have been described by Dice (1930). The grassy wash, wet valley, and dry valley, of which the last two are restricted to the White Sands and the first discontinuously distributed over the desert plain, will be described by the author in a subsequent publication.

Annotated List of Mammals

The present list includes all of the species of mammals recorded from that part of the Tularosa Basin extending from the vicinity of Carrizozo in the north, south to the Escondida red sands. Only the species actually known to occur on the desert plain are included. No attempt has been made to include those forms that occupy the mountains and foot-hills bordering the basin. The taxonomic arrangement follows Miller (1924) except for subsequent changes in the nomenclature. Among the published records cited herein, those of Bailey (1931) usually give only the name of a town, and it is not always certain whether the specimens were collected within the basin or in the nearby foot-hills.

Notiosorex crawfordi crawfordi.—One specimen of this rare desert shrew was taken on November 24, 1938, in the grassy wash association about three miles north of Tularosa. This is the third record known to me of the genus and species from New Mexico and the second record from the Tularosa basin. The previous records were listed by Bailey.

Pipistrellus hesperus maximus. Hatfield.[2]—Dice recorded the canyon bat as abundant at Malpais Spring, 15 miles west of Three Rivers.

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2 Hatfield (1936).

Antrozous pallidus pallidus—Dice recorded one specimen of the pallid bat from Malpais Spring.

Spilogale leucoparia—Benson recorded a spotted skunk from Malpais Spring.

Mephitis mephitis varians—Bailey recorded the striped skunk from Tularosa. Numerous skunk tracks, probably made by this species, were seen on the White Sands.

Taxidea taxus berlandieri—Both Dice and Benson recorded badger tracks and burrows on the White Sands, and the latter observed tracks 10 miles southwest of Tularosa.

Vulpes macrotis neomexicana—Numerous tracks attributed to the kit fox were seen on the White Sands. Benson recorded this species from the White Sands. Bailey listed specimens from Tularosa.

Canis latrans subspecies—Coyotes were common on the White Sands, in the mesquite association near Alamogordo, and in the creosote bush association near Tularosa. Dice recorded them from the White Sands and the creosote bush association. Benson found tracks on the White Sands, at Escondida, and on the quartz sands, about 14 miles west of Tularosa.

Lynx rufus baileyi—Dice found a dried wildcat carcass at Malpais Spring.

Citellus variegatus grammurus—One rock squirrel was seen in the creosote bush association near Alamogordo. Dice reported that several individuals were seen in the mesquite association in the same area. This species, however, is restricted mostly to rocky situations, and it is doubtful that it ranges into the center of the basin. Bailey listed specimens from Tularosa.

Citellus variegatus tularosae Benson.[3] Several individuals were seen in lava sinks and on broken masses of lava about 5 miles west of Oscuro. A great deal of color variation was evident in the rock squirrels observed. One individual seemed no darker than typical *grammurus*, while the darkest animal seen had a black hood extending well back over the shoulders. Benson found the species at the northern and southern end of the Malpais and on the Malpais west of Carrizozo. Bradt recorded it from the Malpais northwest of Carrizozo. The race *tularosae* apparently is limited to the Malpais.

Citellus spilosoma major—Four specimens were taken in 1938 in the mesquite association near Alamogordo. The last one was trapped on October 29. This probably represents the approximate beginning of the hibernation period, as extensive trapping failed to take any individuals after this date. Nine were obtained in 1940 in the mesquite association near Alamogordo and 9 were caught on the White Sands. Those from the White Sands are somewhat paler than the Alamogordo specimens. The White Sands specimens were taken in the sumac—yucca and dry valley associations. In the mesquite association the

[3] Benson (1932).

holes of these ground squirrels were found beneath the mesquite. On the White Sands, their holes were beneath rabbit-brush *(Chrysothamnus pulchellus)* and salt-bush *(Atriplex canescens)*. The first ground squirrel in 1940 was caught March 24 in the mesquite association. This probably represents the approximate end of the hibernation period, for the area had been trapped for about a month without catching any ground squirrels. One of the females from the White Sands gave birth to 6 young on May 14. Dice recorded the species from the mesquite association near Alamogordo and from the atriplex association 10 miles west of Alamogordo. Benson recorded it from the White Sands and from the quartz sands. Bailey listed specimens from Alamogordo and Carrizozo.

Citellus interpres—Benson took 3 specimens of the antelope ground squirrel on the Malpais near Carrizozo. Bradt also recorded it from the same area.

Cynomys ludovicianus arizonensis—Prairire dogs were rare in the Tularosa basin, due evidently to systematic poisoning. No colonies were seen. Benson reported a deserted colony near Cerrito Tularosa, and a small colony southwest of Alamogordo. Dice recorded a small colony in the mesquite association about one mile north of Alamogordo.

Thomomys baileyi tularosae Hall.[4]—Five specimens of this pocket-gopher were collected in the creosote bush association about two miles north of Alamogordo. Two were taken in the atriplex association about 11 miles southwest of Alamogordo. Six were trapped in a clearing in the mesquite association about three miles southwest of Alamogordo. An abundance of mounds at all of these stations indicated large pocket-gopher populations. Both Benson and Bailey recorded this form from near Tularosa. Dice collected two specimens at Alamogordo. The specimens from 11 miles southwest of Alamogordo extend the range of this pocket-gopher far out into the Tularosa Basin and to within about 4 miles of the edge of the White Sands.

Geomys arenarius brevirostris Hall.[5]—Four specimens were collected in 1938 from a large colony near a pond on the edge of the quartz sands about 10 miles west of Tularosa. This apparently is the same locality at which Benson previously collected a series. Four specimens were collected in the wet valley association of the White Sands in 1938, and two were taken there in 1940. Pocket-gopher mounds were numerous in the dry valley association, but they were seldom seen in the sumac—yucca association. In many places both the dry and wet valley associations were literally undermined by the tunnels of this gopher. Several old tunnels were excavated, and the old mounds almost invariably had a clump of bunch-grass *(Andropogon scoparius* var. *neomexicanus)* growing on them. Conversely, excavation at the base of a clump of this grass almost invariably revealed that it was on an old gopher mound. It seems quite possible that there is an intimate ecological relationship between this grass and the pocket-gopher, and that the grass grows more successfully on the

4 Hall (1932b).

5 Hall (1932a).

mounds than on the valley floor. It is possible, of course, that the gophers burrow to the clumps of grass and throw up mounds around them. Most of the fresh mounds, however, were not found around the grass clumps, so the first possibility seems to be most plausible. The excrement of the gophers, being rich in nitrogen compounds, would be favorable for plant growth. The old tunnels were found to be used by the gypsum pocket-mouse *(Perognathus apache gypsi)*. An adult male kangaroo rat *(Dipodomys ordii ordii)* was trapped in an old pocket-gopher tunnel in the wet valley association.

On the White Sands, from one to four trails radiating out from many of the fresh mounds and unplugged holes indicated that the pocket-gopher there frequently leave their tunnels. The trails showed that the animals usually stay within about 6 feet of the hole from which they emerge, although they occasionally travel relatively long distances overland.

Cratogeomys castanops lacrimalis Nelson and Goldman.[6]—Benson recorded one taken "on a gypsum flat within the White Sands 18 miles southwest of Alamogordo." Bailey listed specimens from 9 miles south of Tularosa.

Perognathus flavus flavus—Five specimens of this little pocket-mouse were taken in 1938 in the grassy wash association near Tularosa and two were trapped in the same association at Salinas. Another was obtained in the dry valley association of the White Sands. In 1940, two were trapped in the mesquite association near Alamogordo, and one was caught in the wet valley association of the White Sands. Dice recorded one from the mesquite association near Alamogordo. Benson listed 6 from the White Sands. Bradt recorded this form near the edge of the Malpais west and northwest of Carrizozo. Bailey listed specimens from Carrizozo and Tularosa.

Perognathus apache gypsi Dice.[7]—Seven specimens of the gypsum pocket-mouse were taken in 1938, in the dry valley association of the White Sands, and two were obtained in the wet valley association. The species was quite abundant in the dry valley association, as numerous tracks and holes indicated. However, cold weather at the particular trapping period rendered the mice rather inactive. Five of the 9 specimens obtained were caught on a single, cloudy, relatively-warm night. At that time of year the white pocket-mice were feeding almost entirely on the seeds of a bunch-grass *(Andropogon scoparius* var. *neomexicanus)* and rabbit-brush *(Chrysothamnus pulchellus)*. Many trails that apparently were made by this species led to small much-used holes that invariably connected with old pocket-gopher tunnels. Usually a tunnel system would have two of these tiny tunnels entering it. Efforts to dig the mice out of these tunnels were futile because of the great extent and complexity of the systems. Signs of these mice were much more abundant in the dry valley than in the wet valley association. The two specimens that were obtained in the latter were taken on small vegetated hummocks that projected above the wet floor of the valley. Both Dice and Benson recorded the species from the White Sands.

6 Nelson and Goldman (1934).
7 Dice (1929).

Perognathus penicillatus eremicus—This pocket-mouse was found in 1938 to be extremely abundant in the creosote bush association near Tularosa. Pocket-mouse colonies were found about the bases of roughly 75 per cent of the creosote bushes and mesquite clumps in this situation. A few individuals were taken along the edge of the grassy wash association near Tularosa. These probably were wanderers from the contiguous creosote bush association. Near Alamogordo, the species was somewhat less abundant in the mesquite association than in the creosote bush association at Tularosa. A few individuals were taken in the mesquite association on the quartz sands and along the border of the grassy wash association at Salinas. In 1940, one hundred were trapped in the mesquite and a few in the grassy wash association near Alamogordo and in the sumac—yucca association on the White Sands. Dice recorded the species from the mesquite association near Alamogordo. Benson recorded it from the White Sands, quartz sands, and slopes of Cerrito Tularosa. Bailey recorded it from the creosote bush association near Tularosa.

Perognathus intermedius intermedius—Benson recorded this pocket-mouse from the rocky slopes of Cerrito Tularosa. It is largely restricted to rocky situations, and therefore apparently is absent from most of the Tularosa basin.

Perognathus intermedius ater Dice.[8]—Two specimens of this dark race were taken in 1938 on the Malpais west of Carrizozo. Three were trapped in 1940 on the Malpais west of Oscuro. Dice took this form at Malpais Spring. Benson recorded it from the Malpais Spring and from the vicinity of Carrizozo. Bradt recorded it from the Malpais west and northwest of Carrizozo. Thus this dark colored race is widely distributed over the Malpais, to which it apparently is closely confined.

Dipodomys spectabilis baileyi—One individual was found dead in 1938 on the highway crossing the Malpais lava association about 7 miles west of Carrizozo. In 1940, a few holes were found in pockets of soil on the Malpais west of Oscuro. These are the first records of the species from the Malpais, and it seems probable that it is scarce there. Several dens, evidently belonging to this species, were seen in the wet valley association in the edge of the White Sands. Ranger George Sholly said that he had caught banner-tailed kangaroo-rats in the edge of the White Sands and in the atriplex association bordering them. Benson recorded one from grassland about 12 miles northwest of Carrizozo.

Dipodomys merriami ambiguus—This kangaroo-rat was very abundant in 1938 in the creosote bush association near Tularosa and in the mesquite association near Alamogordo. In these places it was second only to a pocket-mouse (*Perognathus penicillatus eremicus*) in abundance. It also was abundant in the mesquite association on the quartz sands. A few individuals were trapped in the grassy wash association near Tularosa and Salinas. In 1940 we trapped 144 in the mesquite association near Alamogordo and a few in the sumac—yucca association of the White Sands. One of the individuals taken near Alamogordo was a light neutral gray in color. Dice recorded the species from

[8] Dice (1929).

the mesquite, creosote bush, and atriplex associations near Alamogordo. Benson recorded it from the White Sands, quartz sands, and Escondida red sands. Bailey listed specimens from Tularosa.

Dipodomys ordii ordii—This kangaroo-rat was only slightly less abundant in 1938 than the four-toed species *(D. merriami)* in the mesquite association near Alamogordo, but it was rare in the creosote bush association near Tularosa. It was common in the mesquite association on the quartz sands, and a few individuals were taken in the grassy wash association near Tularosa and Salinas. In 1940 the species was found in the mesquite association near Alamogordo where 109 were trapped and in the wet valley and sumac—yucca associations of the White Sands. In the wet valley association an adult male was trapped in an old pocket-gopher *(Geomys)* tunnel. Dice recorded this kangaroo-rat from the mesquite and atriplex associations near Alamogordo and from the White Sands. Benson recorded it from the White Sands, quartz sands, and Escondida red sands. Bradt trapped one on the edge of the Malpais west of Carrizozo, and one on the edge of the Malpais northwest of Carrizozo. Bailey recorded the species from Tularosa.

Onychomys leucogaster ruidosae—One was taken in 1938 in the grassy wash association near Tularosa. Four were trapped in 1940 in the mesquite association near Alamogordo. Dice recorded one from the mesquite near Alamogordo and one from the White Sands. Benson recorded the species from the White Sands, quartz sands, and Escondida red sands. Hollister (1914:449) listed specimens from Carrizozo.

Onychomys torridus torridus—Fourteen individuals were trapped in 1940 in the mesquite association near Alamogordo. Several were trapped there in 1938, but no record of the number was kept and no specimens were saved. A few were caught in 1940 on the White Sands. Dice recorded this species from the mesquite and creosote bush associations near Alamogordo. Benson recordede it from the White Sands and the quartz sands. Bailey listed specimens from Tularosa.

Reithrodontomys megalotis megalotis—This harvest-mouse was common in 1938 in the grassy wash association and along irrigation ditches near Tularosa and Salinas. It was abundant in 1940 in the same association near Alamogordo. Dice recorded the species from the mesquite and grassy wash associations near Alamogordo. Benson recorded it from the White Sands, from the alkali flat at Malpais Spring, and from grass at the edge of the Malpais northwest of Carrizozo. Bailey recorded it from along irrigation ditches near Tularosa.

Peromyscus eremicus eremicus—Nine cactus mice were collected in 1938 in the mesquite association near Alamogordo, and an equal number were trapped in the same association on the quartz sands about 12 miles west of Tularosa. Fifteen were obtained in the grassy wash association near Tularosa, and a few were taken in the same association near Salinas. One was trapped in the Malpais lava association west of Carrizozo. In 1940, nine were trapped in the same association west of Oscuro. All of the cactus mice obtained at this last

station were taken in lava sinks or near the broken edges of the lava. It is interesting to note that only on the Malpais was this generally saxicolous species taken in rocky situations. At the other places it was taken in situations in which there were no rocks. The species was abundant in the foot-hills of the Sacramento Mountains two to three miles east of the Alamogordo, Tularosa, and Salinas stations. In these places it is possible that the cactus mice ranged down into the basin by way of the numerous washes, which, however, were mostly without rocks. There were no washes at the quartz sands station, and it was over 12 miles to the nearest part of the mountains bordering the basin. There was a small rocky peak (Cerrito Tularosa) about 7 miles distant, and Benson recorded the species from that locality. Benson also recorded the cactus mouse from Malpais Spring. Dice recorded it from Malpais Spring and from a rocky arroyo near Alamogordo. Bradt recorded it from the Malpais near Carrizozo. Osgood (1909:242) recorded it from Tularosa and Malpais Spring.

Peromyscus maniculatus blandus—Near Alamogordo, 189 deer-mice were collected in 1938 in the mesquite association. On the quartz sands, 63 were obtained in the same association. In the grassy wash association near Tularosa, 124 were trapped, and in the creosote bush association two were obtained. One was trapped in a rocky arroyo about 4 miles northeast of Tularosa. At Salinas, 87 were taken in the grassy wash association. On the White Sands, 15 were obtained. Most of those from the White Sands were taken about sumac and other woody plants along the border between the sumac—yucca and the wet and dry valley associations. Two of the mice were trapped near yucca plants in the wet valley association. One deer-mouse that had been caught on the White Sands was given to me by J. Eric Hill of the American Museum of Natural History.

In 1940, one hundred deer-mice were trapped in the mesquite association near Alamogordo. Dice recorded the deer-mouse from the mesquite, creosote bush, atriplex, and grassy wash associations near Alamogordo and from the White Sands. Benson recorded it from the White Plains.

Peromyscus leucopus tornillo—The wood-mouse was fairly common in the mesquite association near Alamogordo in 1938. The species was scarce in the mesquite association on the quartz sands, and only one individual was secured there. It was common in the grassy wash association near Tularosa, and was extremely abundant in the same association at Salinas. The concentration of wood-mice at the latter station must have been enormous. The average width of the association was less than 60 feet, and it was bordered on both sides by the creosote bush association in which the species was not found. When two parallel rows of traps were set in the association with the traps about 20 to 30 feet apart, one-half or more of the traps would contain wood-mice on the first two or three nights of trapping. A conservative, rough estimate of the population density in this situation would be from 90 to 100 individuals per acre. This is a much heavier concentration than I have ever encountered before in the wood-mouse, and it is considerably more concentrated than the populations of mammals ordinarily encountered.

Twenty-four wood-mice were obtained in 1940 in the grassy wash association near Alamogordo. Eighteen were trapped in the mesquite association near Alamogordo. Benson recorded the species from the vicinity of a spring near Cerrito Tularosa and from the Escondida red sands.

Peromsycus truei truei—One specimen of the pinyon mouse was taken in the creosote bush and three in the grassy wash association near Tularosa. Except on the Malpais, this is the first record of this generally saxicolous species from within the Tularosa basin, although it has been taken in the mountains on both sides. The place where the specimens were taken was from two to three miles from the base of the mountains, and there were no rocky situations nearer than that. Bradt recorded the species from the Malpais west and northwest of Carrizozo.

Peromyscus nasutus nasutus—Three specimens of the juniper mouse were collected in 1938 in the grassy wash association near Tularosa. This is the first record of this generally saxicolous race from within the Tularosa basin although it has been taken in the mountains on both sides of the basin. The place where these specimens were taken was between two and three miles from the base of the nearest mountains, and there were no rocky situations nearer than that.

Peromyscus nasutus griseus Benson.[9]—Three specimens of this dark race of the juniper mouse were taken in 1938 in the Malpais lava association west of Carrizozo. In 1940, five were obtained in the same association west of Oscuro. Benson recorded this form from Malpais Spring, and from the Malpais west and northwest of Carrizozo. Bradt likewise recorded it from the Malpais west and northwest of Carrizozo.

Sigmodon hispidus berlandieri—This species of cotton-rat was common in 1938 in the grassy wash association near Tularosa and Salinas. Three specimens were taken in 1938 in the mesquite association near Alamogordo, but the species was rare in this habitat. Several were trapped in 1940 in the grassy wash association near Alamogordo. Dice took one in mesquite and another in grassy wash association near Alamogordo. Bailey recorded the species from Tularosa. This species appears to be very discontinuous in its distribution in the Tularosa basin, being largely confined to the grassy wash association which is widely scattered in the area.

Neotoma micropus canescens—The plains wood-rat was very abundant in 1938 in the mesquite association near Alamogordo. At this place almost every large clump of mesquite had one or more inhabited nests. The species was not common in the creosote bush association near Tularosa, but it did occur in the few large clumps of mesquite there. A few individuals were taken in the grassy wash association near Tularosa and Salinas and in the mesquite association on the quartz sands. In 1940, the plains wood-rat was much scarcer in the mesquite association near Alamogordo than it had been in 1938. Numerous nests were seen, but many of them were uninhabited. An old nest, presumably belonging to this species, was seen in the wet valley association, within the edge of the

9 Benson (1932).

White Sands. A few wood-rat tracks were seen in the sumac—yucca and dry valley associations in the interior of the White Sands. Dice recorded the species from the mesquite association near Alamogordo. Bailey listed specimens from near Tularosa. Bradt recorded this species from the western edge of the Malpais west of Carrizozo.

Neotoma albigula albigula—Four specimens of the white-throated woodrat were taken in 1938 in an arroyo about 4 miles northeast of Tularosa. Two of these were trapped in the steep, rocky part of the arroyo, where it was bordered by the sotol—ocotillo association (see Dice, 1930:13) of the lower mountain slopes. The others were taken in the arroyo where it extended out across an alluvial fan occupied by the creosote bush association. There were no rocks in this latter area. Two individuals were trapped in the grassy wash association near Tularosa. These specimens of a generally saxicolous form were taken more than two miles from the nearest rocky situation. The species had previously been taken in the region only near rocks. In 1940, one was trapped in the mesquite association near Alamogordo and about two miles from the rocky foothills bordering the basin. Benson recorded one from the slopes of Cerrito Tularosa. Dice recorded the species from a rocky arroyo near Alamogordo. Goldman (1910:33) recorded the species from Tularosa.

Neotoma albigula melas Dice[10]—Two specimens of this dark race of the white-throated woodrat were collected in 1938 on the Malpais west of Carrizozo. One of these, a young adult male, was trapped at about 10 A.M., after it had been seen moving about in a crevice in the lava. In 1940, seven were trapped in lava sinks west of Oscuro. In the sinks where they were caught there were enormous masses of cholla (*Opuntia* sp.) cactus joints and thorns protecting the woodrats' nests. One of the females gave birth to two young on May 5, and another bore two young on May 24. In each litter, one of the young was considerably darker than the other. Dice recorded this form from the Malpais at Malpais Spring. Bradt recorded it from the Malpais west and northwest of Carrizozo. Benson recorded it from Malpais Spring and from the Malpais west of Carrizozo.

Neotoma mexicana atrata Burt.[11]—One specimen of this dark race of the Mexican woodrat was trapped on the Malpais west of Carrizozo. It was caught in a small cove in the lava bed and near a large pile of massive lava fragments. One specimen had previously been collected by Dice at the same station in 1937.

Erethizon epixanthum subspecies. On May 15, 1940, Ranger George Sholly, accompanied by the author, discovered a considerable quantity of porcupine hair in a bird nest near the National Monument tool shed in the edge of the White Sands. As this was near the middle of the basin, it seems improbable that the hair was transported from the mountains.

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10 Dice (1929).

11 Burt (1939).

Lepus californicus texianus—Jackrabbits frequently were seen in 1938 in the mesquite and creosote bush associations near Alamogordo and Tularosa. One was seen on the White Sands. In 1940, they were numerous in the mesquite association near Alamogordo. At this time their diet apparently consisted almost wholly of mesquite bark until after the beginning of the growing season, when they fed on tender twigs and leaves of the mesquite. They also were eating a mustard *(Lepidium alyssoides)*. Dice recorded this species from the mesquite, grassy wash, creosote bush, and atriplex associations and from the White Sands. Benson recorded it from the White Sands, quartz sands, Escondida red sands, and from the Malpais northwest of Carrizozo.

Sylvilagus audubonii minor—Cottontails were most numerous in 1938 in the grassy wash association near Tularosa and Salinas. However, a few were seen in the mesquite association near Alamogordo. In 1940, they were abundant in the mesquite association near Alamogordo where their food habits were similar to those of the jackrabbit. Dice recorded the cottontail from the mesquite and creosote bush associations near Alamogordo and from the Malpais at Malpais Spring. Benson recorded the species from the White Sands, quartz sands, Escondida red sands and from the Malpais at Malpais Spring and northwest of Carrizozo.

Odocoileus sp.—Ranger George Sholly reported that he has seen several deer trails on the White Sands. He believes that they were made by deer crossing from the mountains on one side of the basin to those on the other. Deer tracks were seen in the mesquite association near Alamogordo in 1940. I do not know whether these tracks were made by the mule deer *(Odocoileus hemionus)* or by the white-tail deer *(Odocoileus virginianus)*, as both are reported from the nearby mountains.

Antilocapra americana mexicana—Ligon (1927:86) reported that 8 pronghorns were then living on the White Sands.

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Food Habits of the Collared Lizard in Northeastern Oklahoma

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Ninety-one specimens of the collared lizard *(Crotaphytus collaris collaris)* were collected in northeastern Oklahoma between March 21 and September 7, 1936. All but one were taken in Osage or Rogers County. The one exception was obtained in Noble County. Sixty-six of the stomachs contained identifiable food remains totaling 314 items. Although the number of stomachs and food items is not large, the material available gives an indication of the food preferences of this lizard in northeastern Oklahoma.

We are indebted to several individuals for kindly identifying the various food items. Many of the determinations were made by T. H. Hubbell of the University of Florida and Irving J. Cantrall of the University of Michigan. Others were made by the Section of Food Habits Research of the United States Fish and Wildlife Service. For these last, we are particularly indebted to Clarence Cottam. We are indebted to J. Speed Rogers of the University of Florida for determining the crane-flies.

Identification of Food Items

Of the 314 items identified in the collared lizard stomachs, 286 were insects. Of these, 214 were Orthoptera, 29 were Coleoptera, 16 were Lepidoptera, 8 were Hemiptera, 8 were Hymenoptera, 6 were Diptera, three were Neuroptera, and two were Homoptera. There were 18 Arachnida. One belonged to the Chilopoda. Two land snails (Gastropoda) were found. There were 7 miscellaneous items that probably were not food. These last included small rocks, pieces of charcoal, and seeds, which probably were ingested with food items. A detailed classification of the food items is given below. Each name is followed (in parentheses) by the number of items of that form recorded and by the first and last date on which it was found.

ORTHOPTERA

Nomotettix cristatus denticulatus (3) May 4; *Mermiria picta* (1) June 11, *Mermiria* sp. (1) September 6; *Syrbula admirabilis* (10) August 12-September 6; *Eritettix simplex* (1) April 12; *Orphulella speciosa* (2) September 6; *Psoloessa t. texana* (4) April 12; *Boöpedon auriventris* (1) July 23; *Arphia sulphurea* (10) March 21-April 12, *A. xanthoptera* (1) April 12, *A. simplex* (2) May 16-June 23, *Arphia* sp. (24) April 12-September 7; *Chortophaga viridifasciata* (39) April 5-September 6; *Hippiscus rugosus* (1) September 6; *Leprus wheeleri* (2) April 12; *Trachyrhachis kiowa fuscifrons* (2) June 23; *Trimerotropis* sp. (1) June 23; *Schistocerca d. damnifica* (2) April 12; *Hesperotettix speciosus* (2) April 18-June 23; *Melanoplus scudderi latus* (1) June 23, *M. inconspicuus* (7) June 11-23, *M. p. ponderosus* (8) June 11-September 6, *M. differentialis* (3) June 23-September 6, *M. bivittatus* (6) June 11-September 7, *M. confusus* (3) May 2-16, *M. m. mexicanus* (4) June 11-23, *M. k. keeleri* (2) August 12-September 6, *M. foedus iselevi* (12) May 2-August 4, *M. bispinosus* (1)

TABLE 1.—Percentage of each order of insect and of other animals in total number of collared lizard food items identified in half-month periods from March 15 to September 15, 1936.

Classification	Periods											
	March 15-31	April 1-15	May 16-31	April 16-30	May 1-15	June 1-15	June 16-30	July 1-15	July 16-31	August 1-15	August 16-31	Sept. 1-15
Orthoptera	12.5	64.3	63.9	63.9	73.7	100	100	....	100	93.3	....	91.9
Homoptera	3.1	....	....	2.8	....	....	....	....	....	....	....	....
Hemiptera	3.1	3.6	....	8.3	....	....	....	....	....	....	....	2.7
Neuroptera	6.3	....	....	2.8	....	....	....	....	....	....	....	....
Lepidoptera	21.9	4.7	8.3	5.5	....	....	....	....	....	....	....	....
Diptera	9.4	....	5.6	2.8	....	....	....	....	....	....	....	....
Coleoptera	25.0	16.7	11.1	2.8	5.3	....	....	....	....	....	....	2.7
Hymenoptera	3.1	8.3	....	....	....	....	....	....	....	....	....	....
Arachnida	12.5	2.4	11.1	11.1	15.7	....	....	....	....	6.7	....	....
Chilopoda	3.1	....	....	....	....	....	....	....	....	....	....	....
Gastropoda	....	....	....	....	5.3	....	....	....	....	....	....	2.7
Total Items	32	84	36	36	19	23	22	....	3	15	....	37

June 23, *Melanoplus* sp. (15) April 18-September 7; *Dendrotettix quercus* (2) June 11; *Neoconocephalus* sp. (1) September 6; *Miogryllus verticalis* (2) June 11-23; Oedopodinae (not determinable to genus) (13) April 5-August 1; Cyrtacanthacrinae (not determinable to genus) (1) May 2; Acrididae (not determinable to subfamily) (21) April 12-September 6; Orthoptera (not determinable to family) (2) March 21-May 4.

HOMOPTERA

Cicadellidae (not determinable to genus) (2) March 21-May 4.

HEMIPTERA

Euschistus sp. (2) May 4-September 6; Lygaeidae (not determinable to genus) (2) May 2; Pentatomidae (not determinable to genus) (4) March 21-April 5.

NEUROPTERA

Myrmelionidae (not determinable to genus) (1) May 2; Neuroptera (not determinable to family) (2) March 21.

LEPIDOPTERA

Chloripe celtis (1) March 30; Noctuidae (caterpillars, not determinable to genus) (4) April 12; Lepidoptera (caterpillars, indeterminable) (1) April 12; Lepidoptera (adults, indeterminable) (10) March 21-April 25.

DIPTERA

Tipula aspidoptera (2) March 30; Tipulidae (not determinable to genus) (1) April 26; Dasypogoninae (1) May 4; Diptera (indeterminable) (2) March 30-April 25.

COLEOPTERA

Cicindela splendida (2) March 21-April 18, *C. tranquebarica* (5) April 5-25, *Cicindela* sp. (4) March 21-September 6; *Calosoma scrutator* (1) April 18; *Amara* sp. (1) May 16; *Acmaeodora* sp. (1) April 12; *Chrysobothris* sp. (1) April 12; *Trogoderma* sp. (probably *ornata*) (1) May 4; *Anomala* sp. (probably *undulata*) (1) April 12; *Euphoria inda* (4) March 21-30; Elateridae (not determinable to genus) (1) April 5; Scarabaeidae (not determinable to genus) (1) April 5; Rhyncophora (not determinable to family) (5) April 5; Coleoptera (indeterminable) (1) April 12.

HYMENOPTERA

Chrysididae (not determinable to genus) (5) April 5; Andrenidae (not determinable to genus) (3) March 30-April 5.

ARACHNIDA

Lycosidae (not determinable to genus) (3) March 21-May 28; Attidae (not determinable to genus) (7) March 21-August 4; Thomisidae (not determinable to genus) (2) May 28; Araneida (not determinable to family) (6) March 30-May 2.

CHILOPODA

Lithobiidae (not determinable to genus) (1) April 18.

MOLLUSCA

Gastropoda (land snails) (2) May 16-September 6.

MISCELLANEOUS ITEMS

Weed seed (1) July 23; grass seed (1) April 25; charcoal (1) April 25; rocks (largest approximately 8 by 10 by 10 mm.) (4) May 2-July 23.

Discussion

Table 1 shows the percentage of each order of insect and of other animals in the total number of items examined during each half-month period from March 15 to September 15, 1936. During the last half of March almost half of the items were Coleoptera or Lepidoptera. In all subsequent periods, however, the Orthoptera far outnumbered all other insects and other animals combined. In addition to outnumbering the others, the Orthoptera constituted the greatest bulk of the food, as the majority of the grasshoppers were adults of relatively large forms. Among the Orthoptera, 19 genera and 30 species were identified.

It is evident from material at hand that in 1936 the collared lizards in the area from whic r specimens were taken were feeding largely on grasshoppers, except in the very early spring. The predominance of these insects in the collared lizard diet probably is attributable to their ready availability in the situations in which the collared lizards live. Except in early spring, grasshoppers were, to the human eye, the most conspicuous terrestrial insects in the collared lizard habitats.

Force (1925:83) listed Formicidae and Myrmicidae as comprising 90% of the food in 9 collared lizard stomachs from Okmulgee County, Oklahoma. No indication is given of the number of items nor of the dates on which the lizards were taken. Burt (1928:52) indicated that 88.3% of 40 food items in the stomachs of 16 collared lizards from Kansas were Orthoptera. This agrees with our data, which indicate that Orthoptera comprise the principal food of collared lizards in northeastern Oklahoma.

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BURT, C. E. 1928—Insect food of Kansas lizards with notes on feeding habits. Jour. Kansas Ent. Soc. **1**:50-68.

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